JOURNAL

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VOLUME 13, NUMBER 1 • JANUARY, 1957

15 Years of Plastics Progress...

SPE'S Annual Conference, Program Page 38

Downtown St. Louis is Site of SPE'S 13th Technical Conference on January 16-18, 1957

YOUR NEW STANDARD

Escambia begins commercial production of PVC resins to bring the calendering, extrusion and molding industries a new standard for comparison.

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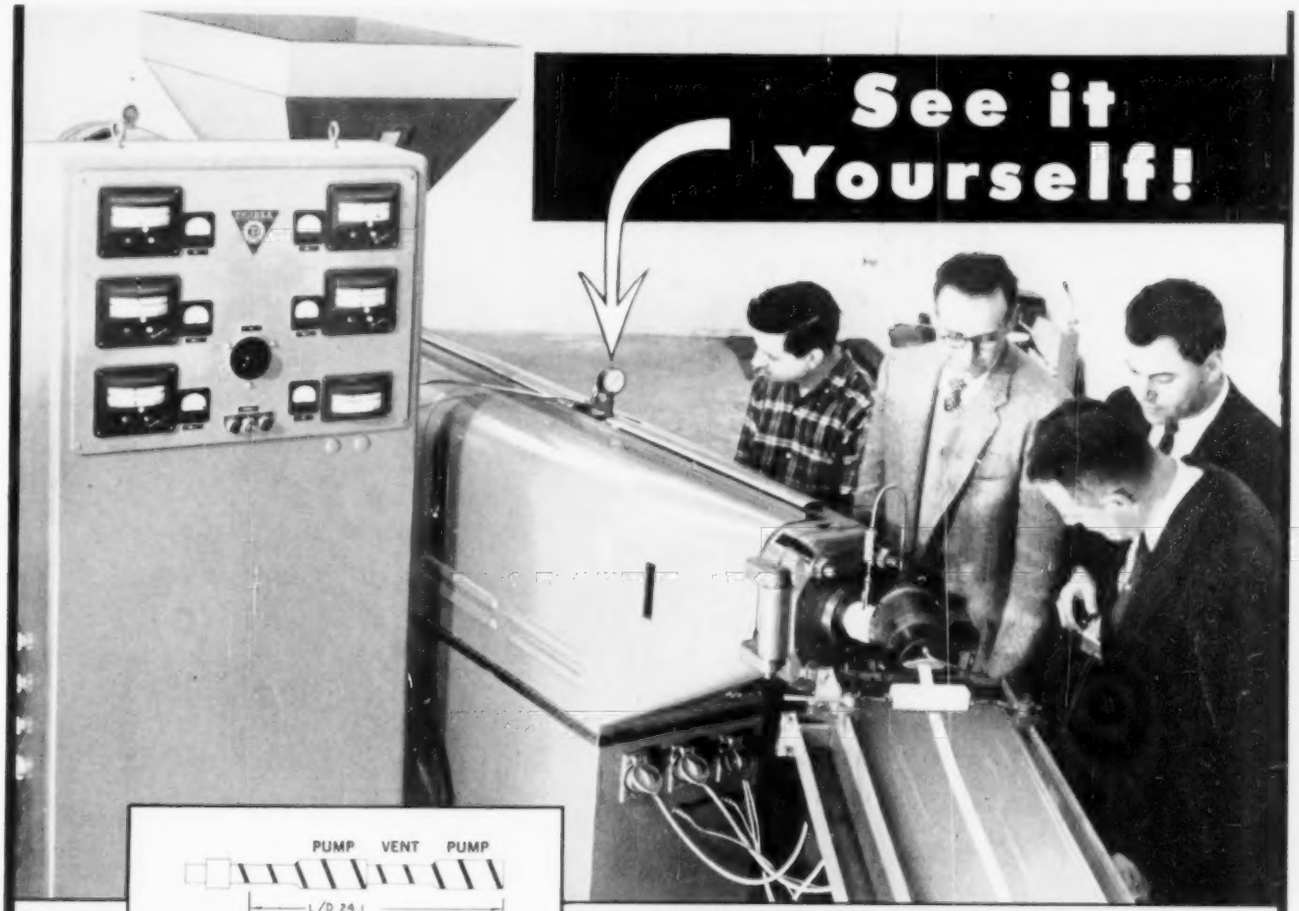

Demonstration of a 4½" Prodex PVP 24 Vented Extruder with 30 degree Prodex cross head. See this machine demonstrated on your own material.

A demonstration proves the superior performance of the Prodex PVP 24 Extruder

The unique Prodex PVP 24 Extruder plasticizes the compound to a uniform melt viscosity. The material is then positively pumped into a devolatizing section where moisture, monomers, air, etc. are removed. A second pump positively meters the compound into the die. This combined action — **Eliminates Porosity — Increases Output — Improves Dispersion — Eliminates Pre-Drying — Reduces Heat Degradation — Improves Precision.**

Typical Production Rates of Prodex PVP 24 Extruders

Extruder Size	Drive H.P.	Cross Section	POUNDS PER HOUR		
			PVC Drybiend	Polyethylene Pipe Cpd.	Polystyrene High Impact
2½"	20	.11 sq. in.	180-240	150-180	150-240
4½"	60	.25 sq. in.	550-660	450-520	500-630
8"	200	1.00 sq. in.	1700-2100	1450-1600	1500-1900

No porosity was present in any of the above extrusions. All compounds contained at least 1% moisture and were not extrudable on ordinary machines without porosity. All rates at precision tolerances.

Prodex PVP 24 Extruders are available in 1¾", 2½", 3½", 4½", 6", 8" sizes.

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U.S.I. POLYETHYLENE PROCESSING TIPS

Vol. II, No. 1

WITH MORE TYPES THAN EVER, HERE'S HELP IN CHOOSING THE RIGHT POLYETHYLENE FOR YOU

In the last year polyethylene has become a whole family of resins with a wide range of properties and many new use possibilities.

Today manufacturers are learning how to tailor polyethylene to almost any end use and processing condition by varying three basic characteristics of the resin in the original manufacturing process:

(1) *Density*
(2) *Molecular Weight*
(3) *Molecular Weight Distribution*

The properties of polyethylene, whether made by a high pressure, modified high pressure, or any of the low pressure processes are fixed by *all three* of these characteristics. An extremely large number of resins having markedly different properties can be produced by controlling these fundamental characteristics.

The processor can usually describe the properties he needs and the manufacturer can then determine which resin is most likely to fill the bill. From that point the two can work together to determine the "ideal" resin for the application.

The following chart shows in very general terms how some of the polymer properties are affected as these characteristics are varied.

Figure I: How Properties Change With Molecular Characteristics

PROPERTY OF POLYETHYLENE	CHARACTERISTIC		
	Increasing Density	Increasing Mol. Wt.	Widening M.W.Dist.
Stiffness	increases	increases slightly	increases slightly
Tensile Yield Point	increases	little or no effect	little or no effect
Film Brittleness	increases	decreases	increases
Softening Point	increases	increases	decreases
Low Temperature Brittleness	decreases	decreases	increases
Resistance to Environmental Stress Cracking	decreases	increases	decreases
Permeability	decreases	little or no effect	little or no effect
Tear Strength (Elmendorf)	decreases	increases	increases
Impact Strength	decreases	increases	—

Effects of Density Variations

The term density describes the weight per unit volume of the resin, and is influenced by the amount of branching in the molecule. Densities can range from 0.910 to 0.965.

The effect of density variations on polyethylene properties will be discussed completely in the next issue of "Polyethylene Processing Tips". You may receive your copy by mail simply by requesting it.

Effects of Molecular Weight

The term molecular weight when applied to polyethylene describes the average or mean size of the molecules in the resin.

Melt index has been used to indicate molecular weight in the past, but since it is also affected by the degree of branching of the molecules, it is a close, but not a completely reliable guide. In these discussions, therefore, we will refer to molecular weight rather than to melt index.

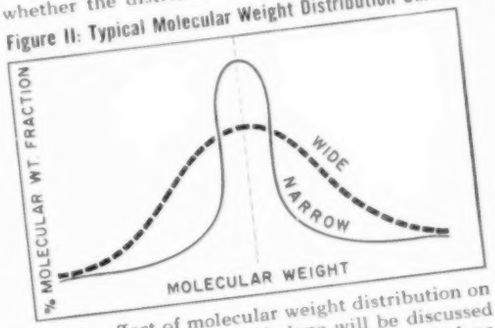
The effect of molecular weight variations on polyethylene properties will be discussed completely in a future issue of "Polyethylene Processing Tips".

Effects of M.W. Distribution

Distribution is determined by measuring how many of each size of molecule is present. When the percentage of each size of molecule is plotted against molecular weight, a distribution curve similar to the one shown below is obtained.

The shape of the curve for each resin tells whether the distribution is wide or narrow.

Figure II: Typical Molecular Weight Distribution Curves



The effect of molecular weight distribution on the properties of polyethylene will be discussed completely in a future issue of "Polyethylene Processing Tips".

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SPE JOURNAL

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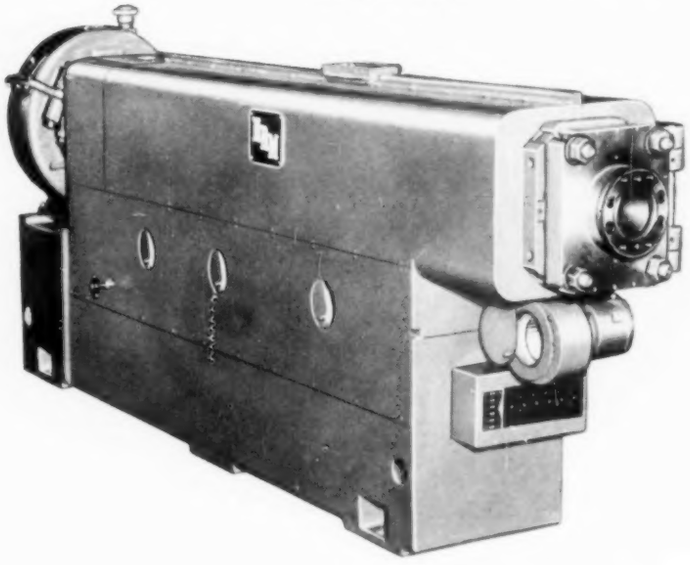

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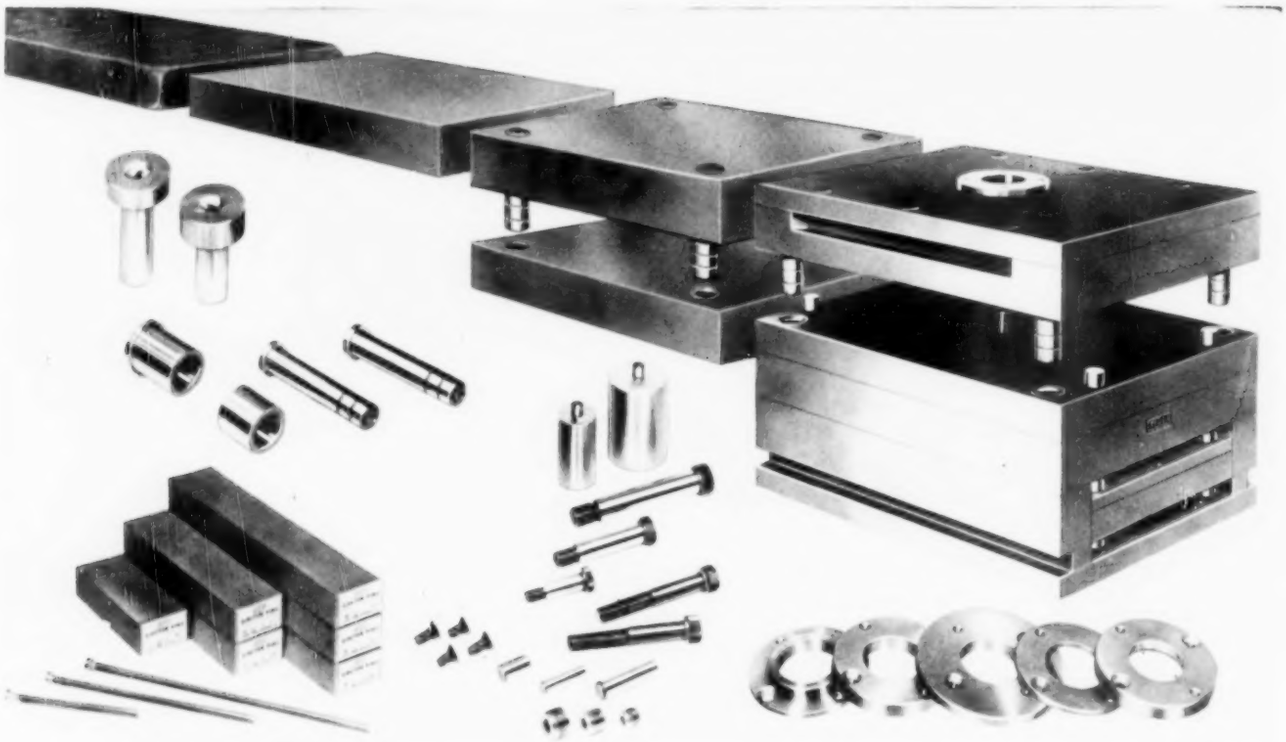

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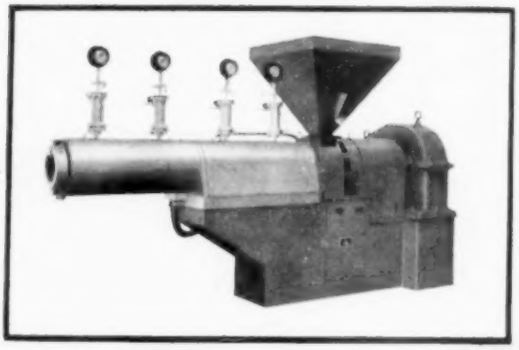

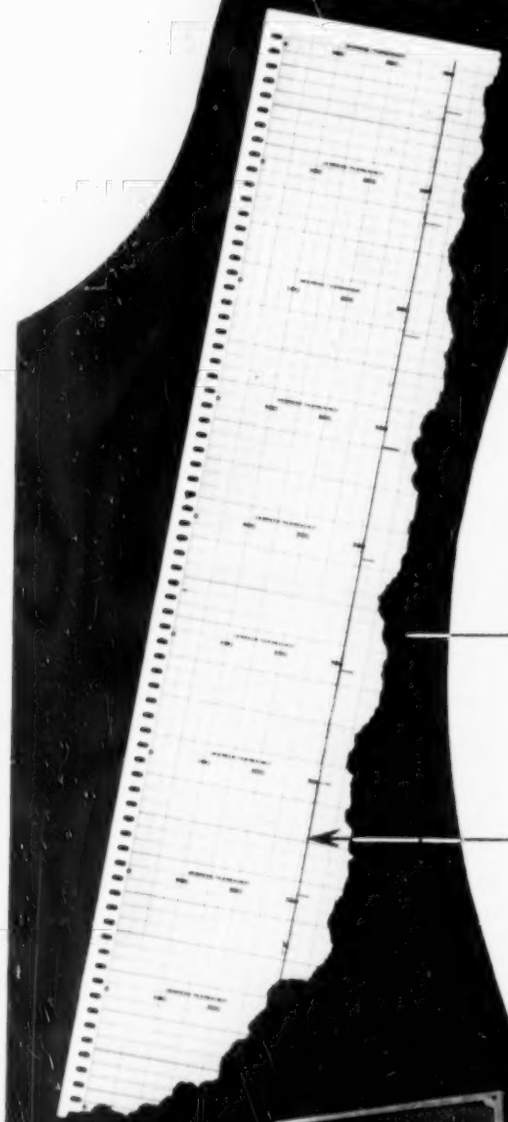

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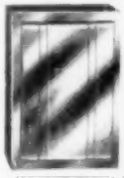

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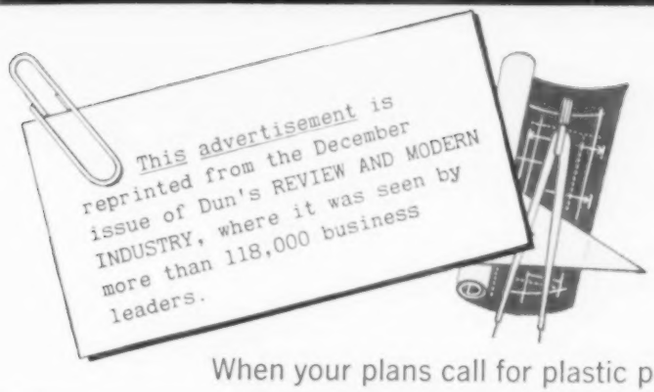
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Traditionally, materials have challenged the artisan. Early inspiration came from gold and silver. Later, it was steel and stone. Today, there are new materials but the challenge is still there. The same priceless skills are now working with the fabulous family of plastics to produce articles by the million that can serve every industry, every home.

Two of these 20th Century craftsmen are pictured on this page. Monsanto, a major producer of quality plastic materials, salutes these molders of America's industrial tomorrow.

When your plans call for plastic parts or products, consult an expert custom molder

Victor Theodore Erickson, Bridgeport Moulded Products, Inc., Bridgeport, Conn. Ted Erickson has been with Bridgeport since 1940. For the past 4 years he has been Supervisor of Engineering, responsible for estimating, tool design, product development, sales engineering, methods, and time study. A large percentage of Bridgeport's business is in the manufacturing of parts for the electrical, refrigeration, air conditioning, business machine, radio, and TV fields. The molding department is equipped with 80 compression molding machines that range in size to 450 tons. There are also 29 presses in the injection molding department with capacity to 200 ozs.

Mr. Erickson believes a job is no better than the design and construction of the tool. "All our work requires close tolerances," he says. "That's why Bridgeport's tool room is as up-to-date as any in the country." On the role of molded plastics in industry, Mr. Erickson points out that "Better and stronger materials are constantly being developed through research. That means we in production have to keep up with these developments. Automation, still in its infancy, carries with it the brightest type of outlook for plastics. We are going to have to bring in more modern equipment, methods, and design to keep up with this progress."

Paul C. Haas, The Haas Corporation, Mendon, Michigan. Mr. Haas heads a company that operates 25 compression molding presses including several 675-ton units. The first products were explosion proof lights and other safety equipment for mines and industry. Now the company turns out 800 different items, including telephone bodies, washing machine parts, and components for the automotive industry. As many as 7 million pieces of a single item have been made in a year.

Mr. Haas feels that research by materials suppliers on the development of new and improved molding compounds is opening new applications for plastics and helping the molder broaden the market for his products. "Improved molding equipment is an important factor too," Mr. Haas points out. "For example, our new 675-ton high-speed presses, equipped with cycle control, insure a more uniform product at reduced costs. And due to the ever improving moldability and physical properties developed by the materials manufacturer," Mr. Haas continues, "bigger and bigger pieces are being made by compression molding. That's why more and more industrial manufacturers like the automotive and appliance industries are turning to the plastics custom molder to help solve production problems and provide improved parts."

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A Spray Method of Applying Polyurethanes

Harold C. Fornwall
The DeVilbiss Company
Toledo, Ohio

CATALYZED MATERIALS are fast becoming one of the most important types of specialty finishes. It is anticipated that many millions of dollars will be saved annually as the result of eliminating or reducing the number of coats and the curing time for each coat in comparison with regular lacquer or synthetic modification now being used today.

Under appropriate conditions, such coatings have much greater durability and also provide increased resistance to chemicals and corrosion, which are highly desired qualities in those many industries where such exposures are common.

Among the latest interesting developments is the spraying of isocyanate prepolymers, which results in an excellent coating that provides both acoustic and thermal insulation, as well as vapor resistance for exterior and interior surfaces above ambient temperatures. In addition, is the use of the DeVilbiss spray gun for molding and casting operations which have involved resin flow rates up to 400 ounces per minute. This method provides the flexibility of spray equipment for the multiplicity of the molds on the average production line.

It is interesting to note that a new vocabulary consistent with the field is being developed which will become as common-place as the general terms now so familiar to the finish technologist as well as the user. While this entire catalyst development is in its infancy today, it could completely change our present concept of finishing materials and methods tomorrow.

Therefore, it might be well to review the history behind the development of the equipment for the application of catalyst finishes.

The Development of Equipment to Apply Catalyst Finishes

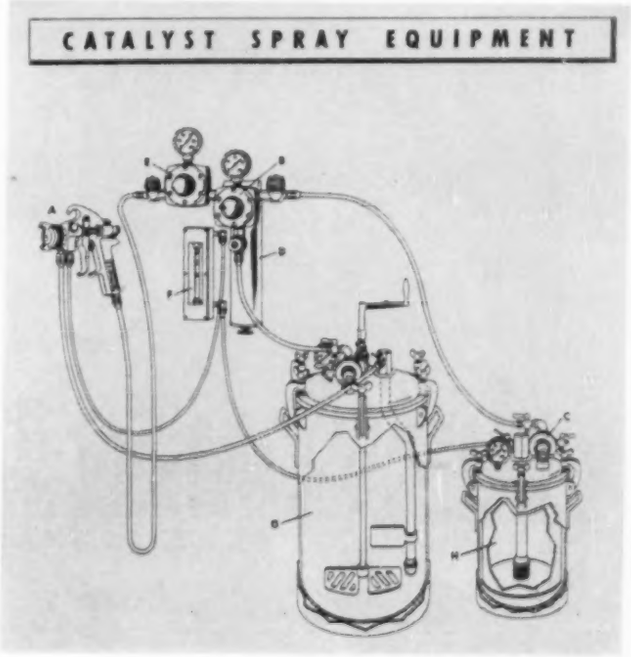
From published information available about three years ago, a multi-purpose investigation was begun.

As the first phase, many calls were made in the field on paint and basic resin manufacturers as well as product finishes users. The aim was to obtain a complete understanding of the requirements for the use of isocyanate prepolymers and associated catalyzed type finishes. There were, of course, many obstacles to the use of catalyst finishes by the average fabricator of the end product. However, based upon a cross index of the completed case histories the following facts were obtained.

A. Five general classes of catalyzed products were found:
   1. Polyester
   2. Epoxy
   3. Conversion Varnish
   4. Iso-Foams (Rigid Type)
   5. Wash Primers

B. Viscosity characteristics of the above could all be adjusted either by reformulation, addition of solvents or by the use of a paint heater down to 50 seconds in a #4 Ford cup or 250 centipoises at 80°F.

C. The various types of catalyst agents required for the above classification involved organic peroxide, aliphatic polyamines and acid glycolether mixtures. All of which are water thin and were used in the ratio range of 2-20% with the required resin.



Presented at 130th meeting of the American Chemical Society, Division of Paint, Plastics and Printing Ink Chemistry.

D. There was the very difficult factor of "pot-life". This is the limited practical working time of a pre-mixture of resin and catalyst. Formerly, when pot-life was extended, the advantages of catalyst finishes were greatly impaired.

E. Lack of a mechanical means of the spray gun type to intermix the two components uniformly, which would allow its application over an extended period. Such a mechanism must give the same end results as though you mixed the two components by hand and spray applied using normal equipment. Failure to achieve thorough dispersion of the catalyst and resin would result in finishes that cured unevenly, which in turn brought a train of undesirable consequences.

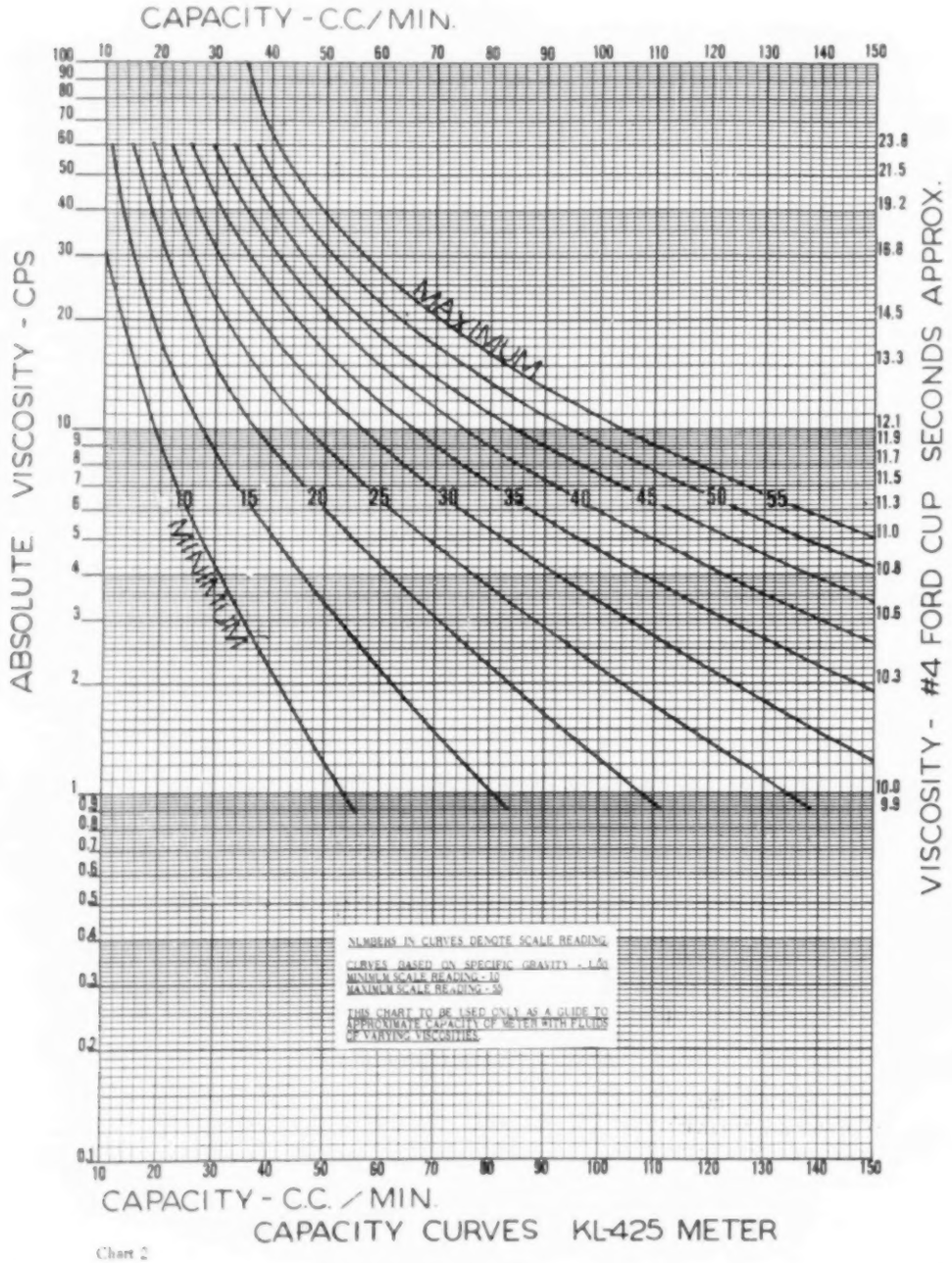
F. The inability to control or change the mixing ratios as production requires.

G. Development of equipment to prevent known reactions that are characteristic of certain materials, having a detrimental effect on the function of the gun.

With sufficient customer interest found, the various requirements for a satisfactory catalyst gun were determined and guns built to meet the needs. They include fluid tips, needles, material passages and connections, built of stainless steel, or in the latter two categories, of aluminum with gaskets made of Teflon. A special hard coating has been developed by The Aluminum Company of America which has shown remarkable resistance to corrosion on the outside of the gun body due to iso-foam application.

The liner of the catalyst hose has been formulated to handle the required corrosive catalysts.

A complete line of pressure tanks for catalyst and resins to include aluminum or stainless steel insert containers, also with or without agitators, are now available for production operations.


CAPACITY - C.C./MIN.
ABSOLUTE VISCOSITY - CPS
VISCOSITY - #4 FORD CUP SECONDS APPROX.
MAXIMUM
MINIMUM
NUMBERS IN CURVES DENOTE SCALE READING
CURVES BASED ON SPECIFIC GRAVITY - 1.50
MINIMUM SCALE READING - 10
MAXIMUM SCALE READING - 55
THIS CHART TO BE USED ONLY AS A GUIDE TO APPROXIMATE CAPACITY OF METER WITH FLUIDS OF VARYING VISCOSITIES
CAPACITY - C.C. / MIN.

CAPACITY CURVES KL-425 METER

Chart 2

A series of calibrated flow meters have been designed to handle the various ranges of viscosities and volumes of catalysts required for this work.

The Catalyst Gun

The gun is unique in that only the catalyst is injected into the center air chamber of the gun with a venturi effect. Consequently, no catalyst enters the horn holes of the air cap. It's a little known fact that the air that comes out of the center holes in the cap develops the major amount of breakup or atomization, while the air coming out of the horn holes in the air cap develops the fan type spray pattern, so necessary for the practical use of the spray gun on the production line.

As you pull the trigger of the gun, the catalyst mixes with the center air stream internally and this produces the necessary mechanical action for intermixing with the fluid (resin) outside the air cap. A complete trigger pull develops the necessary spray pattern. Inasmuch as the catalyst and resin are intermixed outside the gun, the problem of "pot-life" with isocynate prepolymers is completely eliminated. The gun is always ready for application, and can be used for as short or as long a time as necessary to complete the operation.

The flow of the catalyst through the gun can be checked independently, if so desired. All that is necessary is to release the pressure on the resin tank as shown on the included schematic drawing. This allows functional operation of the catalyst unit only without any disconnections.

In order to obtain the proper spray pattern and the spraying speed required, the first step is to adjust for the correct fluid pressure on the resin tank and the corresponding atomization air at the gun. Then turn the atomization air off and permit the fluid to flow freely into a beaker to determine either by weight or volume, the amount of resin being sprayed.

The Catalyst Meter or Gauge

To set the catalyst flow rate, it is first necessary to obtain the paint or resin manufacturer's recommendation for proper proportioning of catalyst and resin. This may be by weight or by volume. When the proper volume of a catalyst is determined, this information may be translated into a scale reading on the meter according to a chart (page 22) we have developed which shows the flow in cc. per minute at any given float reading, depending upon the viscosity of the catalyst.

For example, if you find that you are flowing 700 cc. of resin per minute, and it required 5% catalyst or 35 cc. of catalyst per minute, adjust the pressure on the catalyst tank so that the ball in the flow meter will float at 19 (if the viscosity of the catalyst is 12 seconds).

A flow meter incorporated in the catalyst line for the first time gives the operator a visual means of checking the flow of catalyst, thereby eliminating the previous danger of not being able to maintain the correct amount of catalyst as determined by actual test.

This meter is a precision instrument built specifically to secure accurate, repeatable flow measurements of the principal types of catalysts, falling in any one of the following groups:

1. Organic peroxide catalysts
2. Aliphatic polyamines
3. Sulphuric acid glycolether mixtures

The pressure on the catalyst container is adjusted until the float reaches the proper scale reading while spraying. In this manner, the operator will know that he is spraying catalyst at the proper rate, as predetermined.

The Spraying of Catalysts

The key to the satisfactory use of the aforementioned five types of catalyzed spray formulations centers on their viscosity. It has been found that if the resins can be reduced in viscosity (below 60 seconds #4 Ford cup or 300 Centipoises @ 80°F.) a satisfactory finish coating can be applied. This may be accomplished either by reformulation, the addition of necessary solvents, or by using a paint heater. A deviation from this generalization has been found in the application of semi and resilient type isocyanate prepolymers. These products develop satisfactory characteristics when spray applied at considerably higher viscosities, even when heated to 180°F. The reasoning has been expressed that there is a migration action between the additive and the prepolymer until the reaction is complete.

To date, the successful coatings incorporate catalysts having a viscosity range of 10-15 seconds #4 Ford cup. The practical working ratio of catalyst to resin has been from 2-20% (by volume). The above covers the intermixing range of resins and additives.

Isocyanate prepolymers present a most interesting field. A controlled rigid foam of from ⅛ inch in thickness up to a plus 2 inches has been successfully sprayed. In order to provide industry with greater spraying speed in the semi and resilient iso-foam field, we have developed a round spray cap #129 which makes use of a 9/32 fluid tip. Field tests indicate 400 ounces per minute can be applied for molding or casting operations. This new combination provides a faster 'foaming' reaction with less overspray. Considerable laboratory reformulation work is underway in an effort to reduce the high initial viscosity of this type of resin.

In general the following table of viscosities both at room temperature and elevated, are average for their respective types:

1. Rigid—10,000 C.P.S. at R.T.—250-300 C.P.S. at 180°F. (82.2°C.)
2. Semi—10 to 20,000 C.P.S. at R.T.—300-700 C.P.S. at 180°F. (82.2°C.)
3. Resilient—20,000 C.P.S. at R.T.—1000 C.P.S. at 180°F. (82.2°C.)

Both the semi and resilient type of foam are sprayable, using a developed positive displacement, pumping arrangement. This is necessary due to their high initial viscosity. The extreme rapidity of the initial reaction developed with resilient foams is a direct indication of the complete intermix now obtained with the P-JGC-504 gun. The use of the material heater is very essential in the application of all three types. It allows the users of isocyanate prepolymers to reduce its initial viscosity down to a sprayable consistency.

Research to provide more sprayable combinations is now in process and each day brings about a better understanding of the potential of the spray method as the major method of application. The spray method makes possible the reduction in time of insulating tanks from 8 hours to 40 minutes. The use of sprayed coatings on the back of rugs and carpet as an anchor for the chain stitch as well as for its anti-slip properties opens a tremendous field. Its use in air conditioning, on valves, on pipes, housing, refrigerators, vats, corrugated panels, radio and TV equipment, railroad, general transportation, automotive and aircraft industry, are but a few of its intended adaptations.

Now that the JGC gun and auxiliary equipment have been perfected, and the vexatious obstacle of short pot life has been eliminated, major suppliers of the above types of finishes are re-checking previous formulations in order to obtain those results which formerly were not obtainable.

Care and Maintenance of Equipment

Care and maintenance of the equipment is very simple. However, it is necessary that the gun, flow meter, hose and tanks or containers be washed and dried at the end of operations each day, so as to prevent known reactions that are characteristics of certain materials, having a detrimental effect. This is no more than is required to keep all spray equipment in first class working order. No new technique is required, as a matter of fact, for the use of a hose cleaner will save time and material, and also facilitate a more thorough overall cleaning and drying operation.

Epoxy-Butadiene Resins

C. G. Fitzgerald[a], A. J. Carr[b], M. Maienthal and P. J. Franklin

Diamond Ordnance Fuze Laboratories

In an effort to combine the thermal and electrical properties of cross-linked polybutadiene and the low-temperature curing properties of epoxy resins in a single resin, liquid polybutadiene was epoxidized with peracetic acid in chloroform solution. Polymers of epoxy-oxygen content up to about 8.3%, corresponding to epoxidation of about 39% of the double bonds in polybutadiene, were obtained. The degree of epoxidation was limited by two factors: (1) polybutadiene contains about 40% internal double bonds and 60% terminal double bonds, and (2) infrared spectra showed that, under the conditions of the reaction, the trans internal double bonds reacted readily and completely, the cis internal double bonds reacted only partially, and the terminal double bonds did not react.

The epoxy-polybutadiene resins were cured with a polyfunctional amine and with an anhydride of a dibasic acid. The epoxy-polybutadiene resins with an epoxy-oxygen content of about 2 to 4% either failed to cure or resulted in a friable resin; at somewhat higher epoxy-oxygen contents the resins had good flexibility and promising dielectric properties; above 8% the cured resins were usually hard and brittle.

The dielectric constant and the dissipation factor of a resin containing 6.13% epoxy oxygen are presented as functions of temperature and frequency while the volume resistivity of this same resin is shown as a function of temperature. For a flexible resin, these properties are considered good.

WORK CARRIED OUT previously in this laboratory has shown that cross-linked polybutadiene has electrical and thermal properties superior to those of many other available resins. However, the cross-linking of polybutadiene requires prolonged exposure to elevated temperatures. Epoxy resins, on the other hand, are less stable thermally than cross-linked polybutadiene but they can be cured at relatively low temperatures. The object of the work reported herein was to epoxidize polybutadiene in an effort to obtain a material which would be curable at low temperatures and still have some of the thermal and electrical properties associated with cross-linked polybutadiene.

Although many unsaturated compounds have been epoxidized, and the resulting epoxy compounds used to prepare resins, very little is recorded in the literature regarding the epoxidation of polybutadiene. Kolthoff and co-workers **(1)** epoxidized polybutadiene with perbenzoic acid but they did not isolate the product. Patents by Hillyer and Edmonds **(2)** and Banes and Lippincott **(3)** also describe the epoxidation of polybutadiene but do not mention either isolation or cross-linking of the product. In May 1954 the Becco Chemical Division, Food Machinery and Chemical Corporation, advised this laboratory that it had prepared some samples of epoxidized polybutadiene.

The present report will describe: (1) some experimental epoxidations and isolations of polybutadiene, (2) curing of the product, and (3) some of the electrical properties of the cured materials. This work was begun prior to 1954.

Epoxidation of Polybutadiene and Isolation of the Product

The polybutadiene used in these experiments was furnished by the Phillips Petroleum Company. It had a molecular weight of about 1500. The polymer contained approximately 0.8 double bond per monomer unit of four carbon atoms, or one double bond for every five carbon atoms. The manufacturer reported that it contained 55 to 65% of 1,2 addition units (vinyl groups attached to the chain and designated external double bonds) and 35 to 45% of 1,4 addition units (double bonds located internally within the polymer chain). The method used to determine the ratio of 1,2 to 1,4 units in the polybutadiene employs infrared spectroscopy and has been described by Binder **(4)**.

The polybutadiene was epoxidized with peracetic acid in chloroform by a modification of a method described in the industrial literature **(5)**. The ratio of peracid to polybutadiene was varied to yield varying degrees of epoxidation. The ratios employed are shown in Table 1, column 1, where an equivalent weight of polybutadiene is taken as 70 grams, or that weight which contains one double bond. A typical procedure was as follows:

One equivalent weight (70 grams) of liquid polybutadiene was dissolved in 200 ml of chloroform. This solution was transferred to a three-neck round-bottomed flask equipped with a 500-ml dropping funnel, a mechanical stirrer, and a condenser protected at the open end with a drying tube. Ninety-five grams of 40% peracetic acid (½ mole), together with 5.8 grams of anhydrous sodium acetate to neutralize the small amount of sulfuric acid present as a stabilizer, were added to the dropping funnel. One third of this solution was added to the reaction flask dropwise during the first half hour of the reaction. A water-ice bath was used to maintain the temperature of the

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(a) Present address: Gar Wood Industries, Inc., Ypsilanti, Michigan.

(b) Present address: Meharry Medical College, Nashville, Tennessee.

This article was presented at a symposium on Casting Resins by the Diamond Fuze Laboratories January 1956, and was originally published in the July 1956 issue of Electronic Equipment.

reaction at 15°-20°C (59°-68°F). During the next ½ hr. the remainder of the solution was added from the dropping funnel at a temperature of 20°-25°C (68°-77°F) with continuous stirring. The resulting solution was stirred for an additional four hours at 25°C (77°F). At the end of four hours the reaction mixture was transferred to a 1-liter separatory funnel together with 500 ml of a saturated sodium chloride solution. The combined solutions were gently shaken and allowed to separate. The chloroform layer was washed several times with saturated sodium chloride solution until it was free of acid and gave a negative peroxide test. The chloroform fraction was dried over anhydrous sodium sulfate after which the solvent was removed by heating on a water bath under reduced pressure. Eighty grams of a viscous resinous residue remained in the distillation flask.

Chemical analyses of the product described above using the method of Swern and co-workers (6) showed 6.73% epoxy oxygen, whereas complete utilization of the peracid would have produced 10.25% epoxy oxygen. Examination of Table I shows that, under the reaction conditions employed, percentages of epoxy oxygen higher than 8.3, corresponding to 39% epoxidation of the available double bonds, were not obtained.

Infra-red spectra of the polybutadiene and of the epoxy-polybutadiene resins were compared and it was found that the trans internal double bonds of polybutadiene were epoxidized nearly completely, the cis internal double bonds were partially epoxidized, and the external double bonds had not reacted appreciably. These results agree with results of Kolthoff (1) using perbenzoic acid as an epoxidizing reagent.

Curing of Epoxy-Polybutadiene Resins

The epoxy-polybutadiene resins were cured with a polyfunctional amine (see Table II) and with an anhydride of a diabasic acid (see Table III). Curing was usually done in two stages. The mixture was first heated at 75°C (167°F) until gelation occurred, and then the final curing was done at 120° to 150°C (248° to 302°F).

Electrical Properties of Epoxy-Polybutadiene Resins

Samples of cured resins were machined into discs 2 inches in diameter and 0.2 inch in thickness. The volume resistivity of these samples was measured over the temperature range 25° to 125°C (77° to 257°F) using a null-type electrometer (7), an electrification time of 1 minute, and a potential of 250 volts. Results for a phthalic-anhydride-cured resin containing 6.13% epoxy oxygen are presented in Figure 1.

The dielectric constant and dissipation factor of those same samples were measured over the temperature range -55°C (-67°F) to 155°C (311°F) and over the frequency range 10^2 to 10^5 cps. These measurements were obtained with standard bridge techniques, and the use of a commercial heat exchanger and DOFL-designed sample holder. Resulting data for dielectric constant are shown in Figure 2 and for dissipation factor in Figure 3. Results have been extrapolated to -60°C (-76°F) and to 180°C (356°F) for convenience in comparing this resin with other resins measured in this laboratory.

A comparison of the dielectric properties of the phthalic-anhydride-cured resin with requirements of Military Specification MIL-I-16923B is presented in Table IV.

Discussion

As shown in Tables II and III, the epoxy polybutadiene resins with an epoxy content of about 2 to 4% either failed to form a solid resin or resulted in a friable

Table I.

Epoxidation of polybutadiene with peracetic acid

Moles of peracetic acid per equivalent weight of polybutadiene	Epoxy oxygen, %	Double bonds epoxidized %
⅛	2.04	9.5
¼	4.11	18.7
½	6.73	31.5
¾	7.23	34.1
¾ repeat	7.8	37.0
1	8.06	38.3
2	8.25	39.3

Table II.

Curing conditions and hardness of epoxy-polybutadiene resins using diethylaminopropylamine as a curing agent

Epoxy content, %	Curing agent, %	Curing conditions Hrs.	Temp.°C	Appearance and Shore hardness
2.04	5	29	75	Viscous
		17.5	150	
4.1	5	11	75	Viscous
		17.5	150	
6.92	7.5	22.5	75	Flexible,
		23.5	130	good
7.21	7.5	19.75	75	Flexible,
		23.5	130	fair
7.56	5	30	75	Hard, clear
		17.5	150	C-53
8.06	5	2.5	75	Hard, brittle
		8.5	150	D-63

Table III.

Curing conditions and hardness of epoxy-polybutadiene resins using phthalic anhydride as a curing agent

Epoxy content, %	Curing agent, %	Curing conditions Hrs.	Temp. °C	Appearance and Shore hardness
2.04	5	28	75	Soft,
		17.5	150	friable
4.1	5	10.5	75	Friable
		1	150	
6.13	7.5	17	75	Flexible,
		24.5	120	good,
7.56	5	30	75	Hard, clear
		17.5	150	D-74

Table IV.

Comparison of the dielectric properties of a phthalic-anhydride-cured epoxy-polybutadiene resin with the requirements of Military Specification MIL-I-16923B.

		Dielectric constant-(K)		Dissipation factor	
T°C	Frequency, cps	MIL-I-16923B	Phthalic-anhydride-cured EPB[1]	MIL-I-16923B	Phthalic-anhydride-cured EPB[1]
23	10^2	—	4.7	—	0.04
23	10^3	<4.8	4.4	<0.03	0.05
23	10^4	<4.5	3.5	<0.04	0.06
23	10^5	<4.2	3.2	<0.05	0.05
25	10^5	—	3.0	—	0.06
23	10^5	<4.8	4.4	<0.03	0.05
84	10^5	—	4.6	—	0.03
90	10^5	<4.8	—	<0.04	—
105	10^5	<4.8	—	<0.07	—
116	10^5	—	4.5	—	0.04

[1] EPB = epoxy polybutadiene resin, 6.13% epoxy oxygen

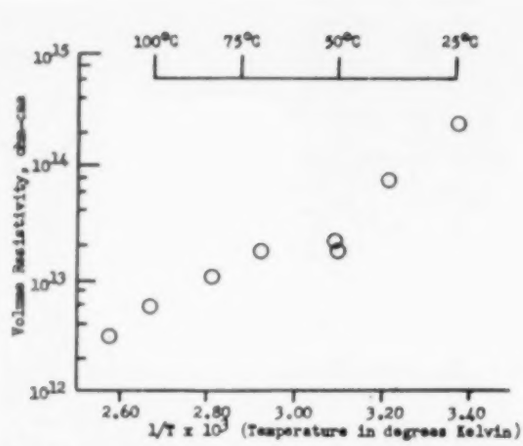

FIGURE 1. - VOLUME RESISTIVITY OF PHTHALIC-ANHYDRIDE-CURED EPOXY POLYBUTADIENE AS A FUNCTION OF TEMPERATURE

resin. At somewhat higher epoxy contents the cured resins had good flexibility. Epoxy polybutadiene resins containing more than 8% epoxy oxygen cured to resins which were usually hard and brittle.

The hardness data given in Tables II and III are incomplete but are included to indicate the level of hardness of materials containing 7 to 8% epoxy oxygen. Quantitative studies of the mechanical properties of these resins remain to be made. The principal immediate observation was that resins containing approximately 6 to 7% epoxy oxygen could be flexed between the fingers.

Comparisons of the efficiency of diethylaminopropylamine and phthalic anhydride as curing agents cannot be made based on the data in Tables II and III because the curing times and temperatures and sample flexibilities were not strictly comparable.

In general, the electrical properties of these resins are considered good for a flexible resin. Figure 1 shows the volume resistivity of the sample which contained 6.13% epoxy oxygen as a function of temperature. The volume resistivity is high over the temperature range 25° to 100°C (77° to 212°F). At 100°C (212°F) it is greater than 10^{13} ohm-cm. In Figure 1, the normal technique of plotting the logarithm of the volume resistivity against the reciprocal of the absolute temperature has been employed. This type of plot usually yields a straight line, the slope of which is proportional to the activation energy of the material. The lack of good fit to a straight line in this case suggests the presence of more than one activation energy for the charge carriers. The very low activation energy (or energies) results in a slow decrease of resistivity with increasing temperature.

The dielectric constant of this same resin is shown as a function of frequency and temperature in the isometric plot presented in Figure 2. The dielectric constant has a maximum of 4.7 at 10^2 cps and 100°C (212°F). The additional increase at higher temperatures is probably due to electrode polarization. The dissipation factor is shown as a function of temperature and frequency in the isometric plot presented in Figure 3. There are two dipolar dispersion regions in this resin. The magnitude of the dissipation factor is no greater than that of other modified epoxy resins of comparable flexibility.

More extensive comparisons of the electrical properties of this resin with those of other casting resins can be made from data presented by Tucker et al (8).

(Please turn to Page 58)

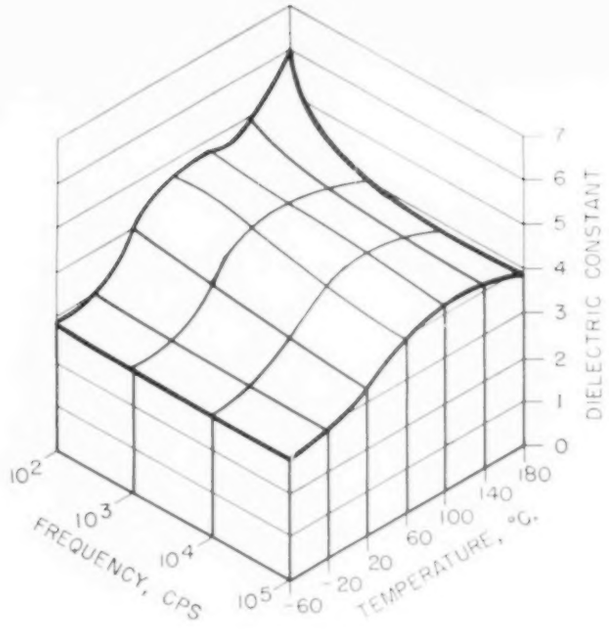

Figure 2.-Dielectric constant of phthalic-anhydride-cured epoxy polybutadiene as a function of temperature and frequency.

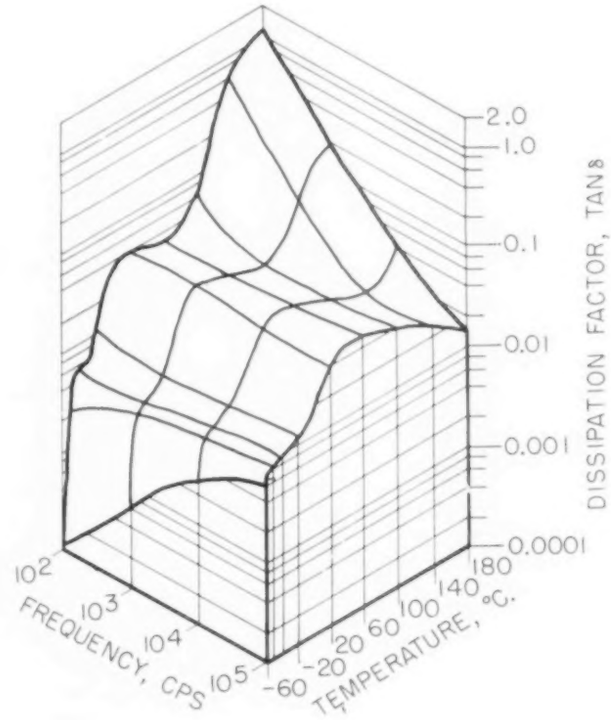

Figure 3.-Dissipation factor of phthalic-anhydride-cured epoxy polybutadiene as a function of temperature and frequency.

Brazing Fundamentals

. . . a basic discussion of a process that can often save money for the plastics molder in die and machine repair . . .

Phillip D. Pilibosian
Standard Steel Treating Co.

PROGRESS over the past several years has been at such a rapid rate that newer methods of assembling parts have been necessary to meet the requirements of designers and to help the manufacturers. This progress has resulted in parts being subjected to greater speeds and higher stresses. New methods of joining parts must be able to satisfy these increasingly higher requirements. Although there are many ways in which metals may be joined, one method, brazing, has gained tremendous stature in recent years, as exhibited by its adoption into the various fields of manufacturing. It is used on parts of all sizes; in business machines and electronic controls, in automotive assemblies, such as power steering and brakes, radiators, and in aircraft controls of all types, many of which are for extremely critical applications, such as automatic pilot controls and fuel control systems.

Brazing has not yet reached this widespread acceptance in the die cast field and plastic die industry. The reason is that little is known of what one might expect from brazed joints, the methods, and the advantages of brazing. It will best serve the purpose of this paper first to discuss brazing in general, considering its variables, such as the variety of brazing methods available, the various brazing alloys and their characteristics, precautions to be taken, design considerations (which incidentally are extremely important), and what one may expect from a brazed joint.

Brazing should first be considered generally as the joining of two parent materials with a dissimilar metal whose melting point is 800 F or higher, such as two pieces of steel joined together with copper. If the material used to join parent materials melts below 800 F, the process is regarded as soldering.

Why Braze?

The first question to arise would be, "Why should we braze?" The answer would be, "Because it can be supported by cost, quality, and performance." For example, the design of a part may be altered if it has had extremely high fabrication costs. The part may be redesigned into a two or even three piece assembly, and then brazed together. Though many designs today are developed with brazing in mind, no general rule can be applied. Each part, or section, must be considered on an individual basis.

I would like to describe briefly the process of brazing. In furnace brazing, which is the most popular and the method which will most assure satisfactory results, the joints to be brazed are assembled and the brazing material is either applied at the joint or has been placed in the form of wire during assembly. The assembly is then passed into the furnace in which a reducing atmosphere is present. This atmosphere serves a three-fold function. It prevents oxidation of the surfaces to be brazed, reduces any oxide present, and keeps the parent material clean, preparing the metal for brazing. As the brazing material melts, it flows over the reduced surface and is drawn into the joints by capillary action and alloys with the parent metal. Upon passing into the cooling zone, the newly formed alloy solidifies and develops great strength.

Capillary Rise

The important principle in brazing is the height to which the fluid will rise by capillary action, and this is dependent on the surface tension of the fluid and the distance between the surfaces to be joined. This is shown by the following formula:

$$h = \frac{2s}{wdg}$$

Where s is the surface tension of the fluid metal, g is the gravitational constant, w is the distance between the surfaces, and d is the density of the brazing material.

Braze materials with high surface tensions, of course, will resist flow or "running," as the free flow of a brazing material is called. The surface tension of a material is greatly reduced as the temperature is increased. This phenomenon is extremely helpful to the heat treater, although the use of excessively high temperatures can cause harmful effects on the material being brazed.

A wide range of brazing alloys is available today, and with the several different means of brazing, many advantages can be obtained from them.

Brazing may be done in a furnace, by torch, induction, resistance, dip, block, and flow. Our purposes would best be served by furnace, torch, and resistance brazing. In torch brazing, the heat is applied by torch with the presence of a flux, which prepares the surface for brazing. The flux serves the same purpose as the furnace atmosphere previously described. Resistance brazing is performed by using the parts to be brazed as part of an electrical circuit. The parts are held between two electrodes and proper pressure and current are applied. The joint becomes heated due to its greater resistance and the braze material melts and flows.

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Today we are brazing and hardening a large number of parts simultaneously in our modern controlled atmosphere furnaces. The best of braze material is simply one which flows at the hardening temperature of the parent materials. In a single operation, the material is brazed and hardened. When processed through a hydrogen furnace, the parts come out with the brightness of a freshly machined part. A number of the air hardening grades which have been hardened in this manner, showed that a considerable number of man-hours have been saved in finishing operations due to this bright finish.

Joint Strength

The materials which melt at the lower temperatures however, do not offer the same strength as pure copper. Where design restrictions are such that maximum strength at the brazed joints is required, then copper is recommended. A subsequent normalizing operation and stress relieving is advisable prior to hardening to refine the coarsened grain caused by the required elevated temperature for copper brazing. The normalizing is necessary in order to produce maximum strength of the parent material after hardening and tempering.

When investigating sections which might be brazed, design considerations are extremely important. It is never recommended that two parts be butted together for brazing. Although this is standard procedure for welding, when joining two sections for brazing, it is recommended that they be joined in th following as shown in the sketch (Figure 1).

During the solidification, the braze material will shrink and form as shown.

This is, of course, exaggerated, but it is a natural phenomenon we cannot overlook. Shrinkage acts as a stress raiser, and when this material is between two sections with a higher modulus of elasticity, concentration of the stress at the joint will cause the braze to tear even though it could be stronger than the parent metal due to its lower modulus of elasticity.

The modulus of elasticity of copper is about 20,000,000 psi, as compared to around 30,000,000 psi, for steel. This means that copper when stressed will deflect 50% more than a steel section of the same cross section. The thicker the cross-sections of the parent material, of course, the less critical this factor will be, but it still should be avoided whenever possible.

Recommended Methods

Figure 2 shows some of the methods which are recommended for obtaining brazed joints of high strength.

Figure 2D-E shows how a gear washer and cup were redesigned for brazing. This assembly was for a clutch. The shoulder was cut into the cup, and the washer was made oversize to fit snugly into the shoulder. The shoulder machined onto the gear rested on the washer and copper paste was applied after assembly. Gravity was utilized, allowing positive flow, and the weight of the gear assured a tight fit throughout the brazing cycle.

There are a great number of ways to fixture assemblies which are to be brazed in order to assure that proper part relationship is maintained. Gravity is utilized to a great extent with the weight of the parts being employed to insure contact of the joining parts. Sometimes additional weights are used. On some extremely critical parts, special fixtures are used. Other methods used to hold parts together for brazing are use of pins, rivets, screws and wooden pegs which burn off during the brazing operation, interlocking seams, tack welding, staking, and dimpling.

Many plastic die sections are hardened and tempered at around 1100-1250°F to get the desired hardness. If a part has been changed so that an addition on the die has to be made and is away from the cavity, this part could easily be added during a re-tempering operation with a braze material which melts at the tempering temperature without changing the hardness. This would save making the whole section over again to incorporate this change. The same principle could, of course, be applied to a new die, and the brazing operation performed during the original tempering operation.

(Please turn to Page 34)

Figure 1. Proper design for brazing two pieces of metal together. Bottom sketch shows normal shrinkage of brazing material.

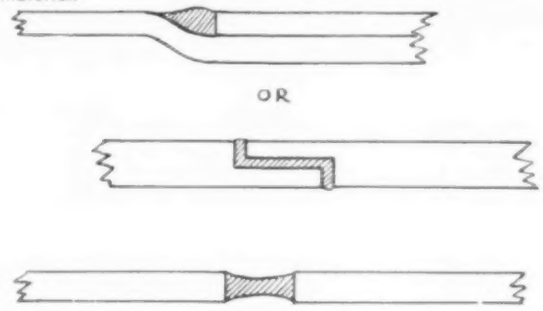


Figure 2. (A) Poor design for a brazed joint of high strength. (B) and (C) Good design for strong joints. (D) Detail of gear-and-cup shoulder redesigned for strength. (E) Gear-and-cup detail before redesign.

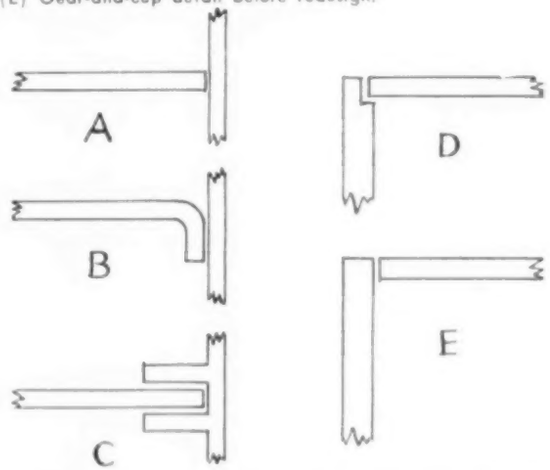
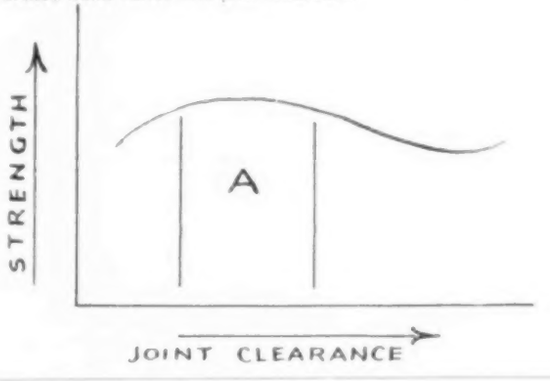


Figure 3. General shape of curve showing how strength of a brazed bond varies with joint clearance.



Effect of Ratio of Diisocyanate Isomers in Polyurethane Foams

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POLYURETHANE FOAMS, which have come into prominence in recent years, may range from the flexible to the rigid types, and both may be prepared by one of two general methods: (1) the three component or "one shot" method, and (2) the two component or "prepolymer" method. Our paper is concerned with the preparation of flexible foams by the former method using polyesters. To review this method briefly, the three component system makes use of a polyester (almost linear in configuration), toluene diisocyanate or TDI, water, and an activator. The last component usually contains the water, an amine catalyst and emulsifiers. The three basic components are proportionately delivered to a common mixing chamber, where chemical reactions begin, and are then discharged into various containers, where the chemical reaction is continued further giving rise to the foam.

A very important step in the formation of polyester-isocyanate foams is the chain elongation which results from the reaction of isocyanate groups with the polyester.

Foam Formation

The formation of foam by reaction of the isocyanate group with water, which liberates carbon dioxide, is another essential step. This reaction also tends to cross-link the various polyester-isocyanate chains.

A third reaction occurs between the carboxyl groups of the polyester giving rise to amide linkages along with more carbon dioxide evolution.

The reactions involved in the formation of polyester-isocyanate foam are complex. The finished foam may contain ester, amide, urea, biuret, allophonate, carbonic anhydride, as well as urethane linkages within the polymer network. All of these are generally lumped together in the polyurethane designation or as favored by some "urethane."

All of the components in the preparation of urethane foams are essential and play an important role in attaining a good cellular structure with desirable physical properties. Probably the most important component is the toluene diisocyanate, or TDI, which with its great reactivity towards all active hydrogen compounds makes the foam reaction possible. Presently, three commercial variations of TDI are available: a relatively pure grade of 2,4 toluene diisocyanate, a mixture containing 80% of the 2,4 isomer with 20% of the 2,6 isomer, and a mixture containing a 65 to 35 ratio of the 2,4 to 2,6 isomers, respectively.

Reaction Complexity

Since the last two types of TDI are probably most used in the preparation of the flexible urethane foams, the complexity of the foam reaction mentioned previously is further increased by the presence of two TDI isomers. The para isocyanate group in the 2,4 isomer is more reactive than the ortho isocyanate group because of the activation and steric influence of the methyl group. The formation of the first urethane link in the course of reaction brings about another activation influence which has not yet been thoroughly explored.

To obtain a practical evaluation as to the effects of these two isomers in foam, a series of foams were prepared wherein materials and conditions were constant and the only variables present were the 2,4 to 2,6 TDI ratios. To further simplify the systems, no oils were used to control cell structure and the activator compositions were made simple.

In the first series of foam experiments, the following formulation was used: 118 parts by weight Multron R-18 polyester, 25 parts by volume TDI, 8 parts by volume activator.

The activator consisted of the following: 3.0 parts by volume tertiary amine, 2.0 parts by volume non-ionic emulsifier, 1.2 parts by volume water.

This is a high density formulation and on a foam machine would produce about a 4.75 lbs./cu. ft. foam product.

The experimental foams were prepared in a half-gallon food container (6 inches high with a 5 inch diameter) and mixed with an air stirrer. The activator was first dispersed in the polyester. To this was added the TDI followed by further mixing until complete miscibility was attained.

Eight foams were prepared as above with the TDI isomer ratio varying from 100% 2,6 to 100% 2,4.

Table I shows the effects of varying TDI isomer ratios on foam time and temperature. The foam time represents the elapsed time from the end of mixing to the time required to reach the highest foam peak.

The foam interior temperature was obtained by inserting a thermometer through the wall of the container

This paper was presented at the Isocyanate Symposium recently held by the Upper Midwest Section of SPE.

TDI Isomer Ratio Effect on Physical Properties

TABLE II

Effects of Varying TDI Isomer Ratios on Low Density Foam Formulations Using Fomrez 50 Polyester

No.	% 2,4 Isomer	% 2,6 Isomer	Foam Time (Seconds)	Foam Temp. °C	Foam Height (Inches)	Density (lbs./cu. ft.)	25% Deflection (10 sq. in.)	% Compression Set
1.	65	35	50	102	4.5	——	——	21.5
2.	68	32	60	103	5.25	——	——	17.6
3.	69.5	30.5	65	100	5.25	——	——	16.8
4.	72	28	75	98	5.35	——	——	18.3
5.	74.5	25.5	75	97	5.5	2.85	16.5	20.2
6.	79	21	85	97.5	5.25	2.75	13.3	21.5
7.	83.3	16.7	90	98	5.5	2.6	12.5	17.3
8.	86	14	90	98	5.75	2.75	17.75	21.5
9.	88	12	90	99	6.0	3.2	21.5	15.0
10.	89.6	10.4	95	97	6.12	——	——	10.8
11.	93.5	6.5	100	95	6.12	2.33	9.8	9.8
12.	96	4	100	93	6.25	2.33	10.5	11.8
13.	100	0	105	92	6.25	2.6	17.2	23.6

TABLE III

Effects of Varying TDI Isomer Ratios on Low Density Foam Formulation Using Multron R-18 Polyester

Foam No.	% 2,4 Isomer	% 2,6 Isomer	Foam Time (Seconds)	Foam Temp. °C	Foam Height (Inches)	Density (lbs./cu. ft.)	25% Deflection (10 sq. in.)	% Compression Set
1.	65	35	70	100	4.75			17.3
2.	68	32	75	99	4.75			16.5
3.	69.5	30.5	75	98	5.0			16.3
4.	72	28	70	99	5.0			14.0
5.	74.5	25.5	75	99	5.0	3.0	16	11.8
6.	79	21	90	98	5.25	3.1	15.7	14.0
7.	83.3	16.7	100	97	6.0			15.7
8.	86	14	100	96	6.0	3.2	11	12.0
9.	88	12	125	95	6.0	2.6	9.25	13.5
10.	89.6	10.4	120	96	5.75			10.3
11.	93.5	6.5	140	95	6.0			12.6
12.	96	4	150	92	6.25	2.5	11	12.6
13.	100	0	240	87	6.25	2.5	10	20.0

TABLE IV

Effects of Varying TDI Isomer Ratios on Physical Properties of Medium Density Foam Formulations Prepared with Machine Mixing

Foam No.	% 2,4 TDI	% 2,6 TDI	Density (lbs./cu. ft.)	% Comp. Set	Tear (lbs./in.)	Tensile (lbs./sq. in)	25% Deflection (lbs./10 sq. in.)	% Rebound (Schoppe)	% Elongation
A	65	35	4.3	14.2	5.2	37.9	16	23	223
B	68	32	3.75	14.3	4.25	38.0	14	22	246
C	71	29	4.25	14.5	3.7	27.9	11.25	43	248
D	76.5	23.5	5.7	19.5	3.15	20.3	8	38	257
E	79	21	4.0	11.4	3.3	21.2	8.25	44	255
F	81	19	3.3	11.6	4.5	23.0	8	23	233
G	83.5	16.5	3.4	10.3	4.2	23.3	11	39	195
H	86	14	3.4	13.5	4.0	31.6	10.75	31	230
I	88	12	4.3	14.3	3.3	28.6	11.25	43	225
J	90	10	5.0	16.3	3.0	20.9	9.5	26	233
K	100	0	shrunk very badly						

at a point two inches from the bottom and with the mercury extending to the center; the thermometer being parallel to the bottom of the container. Previous work showed this area to be the hottest point in this type of foam container.

Highest Foam

The foam with the 100% 2,4 TDI rose the highest, rising some eight inches in height. The least foam rise was that foam prepared from 100% 2,6 TDI, some 3.5 inches. The foam rise appeared to be directly proportional to the percent 2,4 isomer present.

All of the foams prepared with varying amounts of the two isomers were of good initial appearance, though the surface tack increased with higher 2,4 isomer content. The foam made with 100% 2,6 TDI had a number of surface and interior fissures.

On standing overnight at room temperature, the foam containing 80 to 100% of the 2,4 isomer shrunk badly to below the top and away from the sides of the container. In general, the shrinkage in this series of five foams appeared to decrease with increasing 2,6 TDI isomer content.

The foam rise appeared to increase with increasing 2,4 TDI isomer content indicating that the 2,4 isomer reacted to a greater degree with the water, producing more carbon dioxide and hence, more foam height. The foam rise apparently occurred at the expense of chain elongation between the polyester and TDI and/or cross-linking which resulted in shrinkage due to a structure too weak to maintain the fully expanded cells of the foams made with a high 2,4 TDI content.

The foam temperatures only varied some 9 degrees centigrade reaching a maximum with the 80/20 2, 4— 2, 6 isomer ration. The temperature decreased with both lower and higher 2,4 isomer content but seemed to reach a minimum after the 65/35 2,4— 2,6 isomer ratio. However, the scarcity of pure 2,6 TDI, even in research quantities, prevented us from investigating the 65-100% range of 2,6 TDI.

Isomer Ratios

These results were interesting and it was decided to continue the work further, limiting our ratios from the 65/35 blend up to the 100% 2,4 TDI range. Likewise, we wanted to investigate the low density formulations incorporating some anionic emulsified in another system. Two polyesters were also separately evaluated in the following formulation recommended by the Witco Chemical Company:

Fomrez No. 50 or Multron R-18 polyester	67 parts by weight
Witco 77-86	1 part by weight
N-Ethyl Morpholine	1 part by weight
Water	2 parts by weight
TDI	25 parts by volume

Fomrez No. 50 is a polyester with a hydroxyl number of 56.9, and an acid number of 1.6. Viscosity at 28°C. was 13,900 cps.

Multron R-18 polyester had a hydroxyl number of 62 and an acid number of 1.0. Viscosity at 28°C. was 12,900 cps.

Witco 77-86 emulsifier contains 2 parts of a non-ionic together with 1 part anionic surfactants.

As before, the emulsifier, amine, and water were first dispersed in the polyester; followed by the addition of TDI with further mixing. Similar mixing containers were also used. In addition, these foams were post cured for two hours at 100°C. after the maximum foam temperature was determined.

The various TDI isomer ratios were obtained by blending two of the three commercially available TDI grades. The isomer ratio blend obtained by calculation was further verified by infrared spectrographic analysis.

Hydrolyzable chloride values for the 65/35, 80/20, and 100-2,4 grades used alone or in blending were almost similar.

Effects of Variation

Table II lists the effects of varying TDI isomer ratio on this low density formulation using Fomrez No. 50 polyester. Foam time, temperature, and height are shown along with density, 25 percent deflection and percent compression set.

The foam height represents the maximum foam rise at the sides of the container. The foam crowns in the center were generally of different shapes.

Table III lists similar data under similar conditions except that Multron R-18 polyester was used in the foam preparations.

The foaming time of the Fomrez formulation increased progressively in going from the 65/35 TDI ratio to the 100 2,4 isomer. Changes were generally in slight increments and ranged from 50 seconds for the former to 105 seconds for the latter isomer.

Over the same 2,4 to 2,6 isomer range, the foams containing Multron R-18 polyester varied from 70 seconds for the 65/35 blend to 240 seconds for the 100-2,4 in foaming time.

The differences in molar concentrations of polyester would seem to be very slight, yet these differences are real.

For both polyesters, the foam height increases with increasing 2,4 isomer content at very much the same rate. In each type of foam, the 100% 2,4 TDI isomer produced the greatest height. A height close to this maximum is produced with Multron R-18 polyester at about 83/17 TDI isomer ratio. The Fomrez 50 foam appears to approach this maximum at about an 87/13 TDI ratio.

The Fomrez formulations were hotter as determined by exotherm measurements. The foams prepared from the TDI of lower 2,4 isomer contents produced the highest temperatures, 103°C. The lowest exotherm, 92°C., was produced with the 100% 2,4 TDI.

Likewise, the Multron R-18 based foams show the highest exotherm in the 65/35 TDI isomer range with the lowest foam temperature produced with the 100% 2,4 TDI. The exotherms produced by the above two extremes

TABLE I

Effects of Varying TDI Isomer Ratios on Foam Time and Temperature in a High Density Formulation

Foam No.	% 2,4 TDI	% 2,6 TDI	Foam Time (Mins.)	Foam Temp °C.
1.	100	0	5.75	71.7
2.	94.8	5.2	5.5	72.8
3.	90	10	5.0	72.8
4.	84	16	4.0	74.0
5.	80	20	4.0	74.6
6.	72	28	3.25	71.0
7.	65	35	2.0	65.6
8.	0	100	2.0	65.6

in isomer blends ranged from 100°C. to 87°C. respectively. It should be remembered that in data presented earlier using a different formulation that Multron R-18 gave a maximum exotherm at an 80/20 TDI isomer ratio. Apparently, peak exotherm may also be shifted by the choice of formulation.

Fissures

In the isomer ratios covered in this series, only about half of the foams produced were free of fissures enabling us to obtain density and compression deflection data. Density and compression deflection information was obtained on 2 inch thick samples cut out from the original container wherever suitable samples could be obtained.

The lowest densities obtained with the Multron R-18 polyester ranged from 2.6 to 2.5 lbs. per cubic foot with TDI ratios starting at 88/12 and going up to 100% 2,4.

The lowest 25% compression deflection (or lowest stiffness) data for this polyester also follows the same TDI isomer ratios.

On the other hand, the highest density and highest deflection (stiffness) values are obtained at the 88/12 TDI isomer ratio using the Fomrez 50 polyester. The lowest density (2.73 lbs./cu. ft.) and deflection values for this polyester are obtained with TDI isomer ratio of 93.5/6.5 and 96/4.

These differences in density and stiffness occurring at the 88/12 isomer ratio are not readily explainable. We are familiar with the structure of the Multron R-18 polyester, and other than physical properties, we have no other information on Fomrez 50 polyester.

Differences in the degree of cross-linking are about the only possibility that suggests itself as an explanation for the differences in stiffness of foams made with these two polyesters.

Foam surfaces of the Fomrez 50 foams were good for all isomer ratios except for a slight surface shrinkage observed for the 93.5/6.5 and 96/4 TDI ratios.

Foam surfaces of the Multron R-18 foams showed a higher degree of shrinking and wrinkling in the 93.5 - 96% 2, 4 isomer content foam as well as in the 83.5 - 88% 2, 4 TDI isomer content foams. Some appreciable cell size irregularity was also apparent in the 72 - 79% 2, 4 TDI isomer range.

Use of Foam Machine

With some unusual trends in about the 85 - 90% 2, 4 TDI isomer content foam showing up from the above work, it was felt that further information might be obtained using a foam machine.

The machine used is of our own manufacture and is the smallest unit in our laboratories. The activator is generally premixed into the polyester and this mixture is kept in one tank. The other tank serves for TDI storage.

Zenith proportioning pumps are used to deliver separately the desired amounts of polyester-activator combination and TDI to the mixing head.

The mixing head is divided into three sections which are separated by perforated plates. Three turbine types blades are attached to the mixing shaft in each section. Each of the blades also contains two perforations. The blades are machined so that only a small clearance is provided between the blades and the two perforated discs of its section as well as the sides. This type of mixing head provides a shearing action as well as mixing by forcing the materials through the perforations.

The output of the machine for this series of foam was about one pound per minute. The foam was collected in aluminum pans, 5" x 9-½" x 3", in size. After setting up at room temperature, these foams were also post cured at 100°C. for two hours.

The following formulation was used for the machine trials: 90 parts by weight Multron R-18, 1.5 parts by weight tertiary amine, 1.5 parts by weight N-ethyl morpholine, 1.0 parts by weight non-ionic emulsifier, 28.75 parts by weight TDI.

Table IV lists some of the physical properties obtained with machine foaming of the above formulation using TDI containing from 65% to 100% 2, 4 isomer.

The 100% 2, 4 TDI resulted in excessive shrinkage which prohibited sampling for any physical properties.

The 76/24 TDI area resulted in the foam with the highest density (5.7 lbs./cu. ft.) The lowest density foams were obtained using TDI containing from 80 - 85% of the 2, 4 isomer.

Other Results

The compression set values are also highest in the 76/24 isomer area with the lowest values obtained in the TDI with 2,4 isomer content of 80-85%.

Tear values for this machine-made foam were highest for the low 2,4 TDI isomer content and lowest at the 76/24 and 90/10 ratios. The tear data shows the 80/85% 2,4 foams are somewhat intermediate in value.

The highest percent elongation results are provided by foams made up from TDI containing 75-80% of the 2,4 isomer. The area around 83% 2,4 isomer provides us with foams of the lowest elongation.

Tensile strengths are highest for the foams made with the low 2,4 TDI contents and progressively decrease reaching a low value at the 75-80% 2,4 TDI range. Another high point for tensile value again is the 86/14 TDI foam.

The stiffest foams were prepared when the low 2,4 TDI was used. The softest ones were those made from TDI containing 76 to 81% of the 2,4 isomer. Intermediate deflection values were obtained in foams from TDI having an 83 to 88% 2,4 isomer content.

The top surface and cell structure of the foams prepared with the previous formulation were generally good with only a few exceptions. The 65/35 and 68/32 TDI containing foams had smooth surfaces with some fissures present. The 88/12 and 90/10 isomers produced foams without fissures but with considerable wrinkling of the foam surface.

We have shown by the few foam formulations discussed above that there may be a formulation factor which has as yet not been thoroughly exploited, viz., the TDI isomer ratio. It would appear from the data obtained in both "hand" mixed and machine mixed foams, that the 83/17 to the 87/13 TDI isomer range would provide foams with a higher degree of optimum properties, both physical and processing.

Optimum Ratio

While this particular isomer ratio area may vary for an entirely different formulation, there is probably present a TDI isomer blend that can provide the maximum or optimum in physical properties and in processing for any one particular formulation. It may well be worth the few extra cents needed to achieve a particular isomer ratio by blending of the three commercially available TDI products. It also becomes necessary that the suppliers of TDI, in whatever form it may be, provide a constant quality product.

Thermoplastic Pipe

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The factors involved in the use of plastic pipe by an electrical utility are detailed. Environmental test results are given to select one pipe material for all applications, with discussion of results.

THE APPLICATIONS for plastic pipe by an electrical utility can be divided into two categories, electrical and non-electrical. By electrical is meant applications directly associated with electrical conductors, or where certain electrical characteristics are required. Non-electrical applications could be structural, or could be the basic application of pipe, the conveyance of a fluid, usually under pressure.

An important factor needs to be indicated here. In electrical utility stations a good electrical ground is mandatory. Copper is generously used as a lead into the earth to the established grounding. The presence of this copper places a limit to the life obtainable from ferrous pipe in the same general area. Hence, plastic pipe offers a distinct advantage in being a non-conductor. In addition, the over-all cost of installing ferrous pipe with the necessary protective coatings and cathodic protection makes the cost of plastic pipe competitive.

The factors involved in the use of plastic pipe are as follows:

(1) Environmental

Burial in earth is the most likely environment. Soil waters range from the slightly acidic (pH 5) to slightly alkaline (pH 9). Burial or encasement in concrete is also probable. From either earth or concrete the pipe may emerge above ground into the weather. The latter means exposure to the sun and rain, which brings on rapid and wide temperature changes, and to snow. These are the environments outside the pipe.

At the same time the inside of the pipe may be exposed to fluids ranging from potable water to aqueous solutions of salts, acids and alkalies, to non-aqueous fluids such as petroleum products; to gases such as compressed air, hydrogen and carbon dioxide.

Specifically, for the electrical utility, the outside environments are those detailed above, plus abnormal ones underground such as industrial waste and garbage fill; in rare instances, relatively high concentrations of sulfuric acid (pH 2) develop from the pyrites in neighboring bituminous coal piles, and relatively strong alkaline solutions (pH 12) in the neighborhood of large concrete structures.

The interior environments specific to an electrical utility will be potable and industrial water, new and aged insulating oil, and lubricating oil. The gases are those indicated above.

(2) Thermal

The thermal factor exerts three influences. One is the decreased resistance to pressure with rise in temperature; another is the increased rate of absorption or attack by liquids on the plastic as the temperature rises. Experience indicates that where absorption takes place (and no attack), the final total per cent absorption is the same, say for 100°F as for 140°F, but it is reached much sooner at 140°F. Where chemical attack takes place, the rate of attack increases with temperature increase.

Sunlight can raise the temperature of plastic pipe to 150°F. When used to convey insulating oil, the latter may come from the transformer at 140°F. These considerations influenced the selection of 140°F for environmental tests.

If used as a duct or conduit, control or communication cables housed therein will be at ambient temperature. However, power cables of the lead sheathed type are operated at a normal sheath temperature of 140°F. As peak demands occur at lunch and dinner time, one must consider not only the effect of the peak temperature but also of the twice-a-day cycling of temperature. As the plastic pipe is at atmospheric pressure in this application, the effect of temperature concerns only the effect of the weight of the hot cable on the pipe.

The third influence of temperature is to cause pipe to expand or contract. The rate for unrestrained plastic pipe averages about six times that of steel. Our tests have shown, however, that when restrained by earth or concrete, even though not bonded to it, plastic pipe exhibits a small fraction of the length changes of unrestrained pipe.

(3) Electrical

As plastic pipe is inherently an electrical insulator, this characteristic is directly applicable to potential uses such as live-line tool handles and switch sticks. When used as conduit, it may be necessary to include a ground wire in the cables being carried. In the case of a fault between adjacent cables, more data are needed on the effects of such phenomena as intense radiant heat, molten copper spray and the fusion of cable jackets and insulation.

(4) Contamination and Compatibility

(a) Contamination of Fluids Conveyed

The effect of plastic pipe on the fluid it conveys and conversely, the effect of the fluid on the pipe, is of considerable importance. The problem of contamination has received scant notice, probably because early important industrial uses of plastic pipe involved conveying waste water. If this water was contaminated by extractives from the pipe, it was of no consequence. However, to a utility contemplating piping insulating and lubricating oil, the result of contamination of these fluids can be of major importance.

This paper was presented at the recent Regional Symposium held by the Quebec section of SPE.

Considerable work has been done by the National Sanitation Foundation on the effect of plastic pipe on water potability. Most of the resin types have been found suitable for this application. Polyethylene pipe, with a decade of usage experience for conveying water, is probably the most used for potable water.

(b) Compatibility with Cables

All types of cables could be housed in plastic ducts. They could be sheathed in aluminum, lead, neoprene, pvc or polyethylene. They could be insulated in pvc, polyethylene, synthetic rubbers such as GRS and butyl, or in natural rubber. Jointed plastic duct must not exert harmful effects on any of these. Conversely, volatiles from, or physical contact with, warm plastic-insulated or jacketed cables should not permanently alter the original desirable characteristics of the duct material.

(5) Installation Problems

There have been occasions in our experience with plastics wherein we have been convinced that the product would meet all requirements **once installed,** if it could stand the handling associated with installation.

Handling problems arise in the transport of pipe from the manufacturer to the point of assembly. Cold weather, rough roads, unsuitable carriers, too long an overhang of the pipe, poor or widely-spaced supports, unloading by dumping, are all contributors to difficulties in this respect. Proper packing for shipment should minimize or eliminate the hazards.

Assembly problems arise in the joining of pipe; the lavish use of cements (if solvent welded) or the improper thread lubricant; the effect of exposure of an unrestrained (not buried) pipe network to the hot sun and then testing for leaks with cold water under pressure; the use of localized heat or dangerous lubricants when pipe is too tight for the fittings; the inevitable connection of plastic pipe to metal; expansion joints (are there any available?); variation in diameter or circulatory causing projecting edges—a serious fault when pulling cables into a duct—and many others. A not-too-lengthy list of directions, concise and to the point, would help here.

Much emphasis has been placed on high impact resistance at low temperatures because of potential difficulties in assembling pipe at sub-zero temperatures. The writer thinks this feature has been emphasized all out of proportion to its true importance. To get such high impact, it is usually necessary to blend or alloy with the base resin. This is done at the expense of lowering chemical resistance to the point that the pipe has doubtful value. It is highly questionable anyway, whether pipe can be properly assembled, especially SWP, at the sub-zero temperatures for which high impact resistance is claimed.

The Evaluation of Thermoplastic Pipe

When the evaluation of thermoplastic pipe for the various services and exposure was begun, an intriguing possibility suggested itself. Could there be a single resin which would serve all the applications? Obviously, there were tremendous advantages if this were so. It would greatly simplify storage and cataloguing problems. Only one series of fittings would have to be stocked. It would eliminate the possibility of shipping from stores the wrong pipe, or the use of the wrong pipe in the field. In carrying out the program of evaluation this Utopian goal was before us at all times.

As the physical testing of pipe involves much more material, time, effort and equipment than environmental testing*, the latter was undertaken first, to screen the obviously unsuitable and avoid further costly investigation. Six aqueous and three oily environments were chosen, based on experience with normal and subnormal soil conditions and materials likely to be conveyed by the pipe. These are detailed in Appendix I. Two temperatures were chosen for the solutions, 100° and 140°F. Changes in weight, dimensions, appearance and hardness were recorded. Arbitrary limits were set for the change in weight after six months at 140°F—a maximum gain of one per cent, a maximum loss of 0.1 per cent.

Results

As the environmental tests progressed, the possibility that one plastic might serve for all the fluid-conveying applications in mind and under all the environments, did not look so remote as first thought. It was evident later that such a choice could be made. Two types of resins showed promise in this respect, one being styrene-acrylonitrile and the other unplasticized polyvinyl chloride.

Table I is a summary of the results of weight changes for these two:

TABLE I

Unplasticized PVC		
Resin A	**100°F**	**140°F**
Maximum gain at 45 weeks (%)	0.3	1.0
Maximum loss at 45 weeks (%)	0.02	0.05
Resin B		
Maximum gain at 40 weeks (%)	0.5	1.4
Maximum loss at 40 weeks (%)	0.01	0.07
Resin C		
Maximum gain at 26 weeks (%)	0.25	0.26
Maximum loss at 26 weeks (%)	0.02	0.02
Styrene-Acrylonitrile		
Resin D	**100°F**	**140°F**
Maximum gain at 26 weeks (%)	1.0	1.2
Maximum loss at 26 weeks (%)	0	0.2 (in oil)
Resin E		
Maximum gain at 30 weeks (%)	0.6	0.7
Maximum loss at 30 weeks (%)	0	0.2 (in oil)

Discussion of Results

There are relatively few producers of pvc resin, but many fabricators of pipe. Pipe made from the same source of pvc gave marked variation in environmental test results. It is felt that variation in extrusion conditions could result in wide variation in physical test results, but have little effect on chemical resistance. It was soon apparent, therefore, that either the raw material was subject to variation in composition or that fabricators were making additions to the product supplied them and these varied from fabricator to fabricator.

As an example, the results of resin B, shown above, were exceeded by as much as 200 per cent when pipe from the same manufacturer's resin, but a different fabricator, was similarly tested. Resin C is an outstanding one, but is apparently difficult to extrude. Undoubtedly, extrusion aids will be added to facilitate production. Experience has indicated that such additions can take the product from the outstanding class into that of the ordinary.

The difference in the results of the styrene-acrylonitriles is due to the difference in the ratio of the copolymers. Were it not for the high loss in oil, this type of resin would be a strong competitor with unplasticized pvc for the one "general-purpose"pipe.

Physical tests on unplasticized pvc pipe will proceed when (a) pipe is readily available from the selected resin

* *"The Evaluation of Reinforced Plastic Pipe"—11th Annual SPI Reinforced Plastics Conference, February, 1956.*

and (b) fittings are available from the **same** resin.

Application of Thermoplastic Pipe

Two examples of applications of pipe will be detailed to show how the factors enumerated are involved.

(1) Piezometer Tubing

When you wish to determine the performance characteristic of an electrical device, leads are connected from it to various instruments that indicate or record the voltage, current, or wattage. From such values the performance and efficiency of the device can be determined. To determine similar performance of the hydraulic turbine that drives an electric generator, tubing is connected at one end to various openings in the casing of the turbine; the other end is connected to instruments in the control room called flowmeters. These record the pressures at various positions in the hydraulic system and the tubing serves to transmit such static pressures.

Traditionally, the tubing was made of copper embedded for the most part in the concrete around the turbine casing and the building structure. Due either to difficulties arising during installation or to undue stresses placed on the copper, it was not unusual to find the tubing plugged with mortar or cracked when tried for service. As a result of these failures, we were asked whether plastic tubing could be used for this application.

The environmental conditions were reviewed. In placing the concrete, the liquid is highly alkaline. By the end of 24 hours all the water has drained off and the concrete has set. During this time, the temperature is at ambient. The average height of concrete poured today in one lift is about ten feet. This represents a load on the tubing of about 10 psi. Infrequently, concrete has been placed to a lift of twenty-five feet. In a few days the temperature of the concrete rises due to the heat of hydration and, depending on the volume, rises to 140 F°. Then the concrete begins to cool off, returning to ambient in a matter of weeks or months, again depending on the mass of concrete involved.

Ease of Installation

For ease of installation and the coil lengths involved, flexible or semi-flexible tubing was desirable. This requirement narrowed the choice of plastic to polyethylene and pvc (plasticized). So far as resistance to alkalies was concerned, both were considered equal. They could stand equally well the exotherm temperature. It was known, however, that the installation temperature could range from -20 F° to 100 F°. Because of the ease of handling at the low temperature, polyethylene was preferred.

Several questions arose in connection with this application:

1. What distorting effect would a 25-foot lift of concrete have on the pipe? A 50-foot lift?

2. What is the effect during 1 should the pipe rest on sharp aggregate?

3. As there are large differences in the thermal coefficient of expansion, will there be excessive stress as a result of the temperature changes experienced by the concrete-encased pipe?

The first two questions were answered by placing one length of the ¾-inch polyethylene pipe on a relatively sharp grid in an oven at 100 F° with a load of 25 psi resting on it, and a second with a 50 psi load. After 48 hours, the reduction in the OD was 1/32 inch. At 25 psi load very faint indentations were left on the underside of the pipe due to the grid; at 50 psi the indentations were about 5 mils in depth. It was considered there was no need for concern about the first two questions.

Experiments involving the cycling of hot and cold water through a length of polyethylene pipe embedded in concrete showed that the dimensional changes were a small fraction of that exhibited by unrestrained pipe. It was considered that up to a length of about 25 feet, no special treatment was required when embedding the pipe in concrete. In the 50-foot range, however, it was believed some type of expansion joint would be necessary.

Such a joint was developed. Two O-rings were placed, six inches apart, over the ¾-inch pipe and the latter was then forced into 1-inch diameter pipe for a distance of about 12 inches. This joint permitted movement of one with respect to the other and yet hold municipal water pressure. However, on the earliest job where the plastic piezometer tubing was used, an experimental 60-foot length of ¾-inch pipe was embedded under a 10-foot lift of concrete. The latter rose to 140 F°. After several months, when it had cooled back to ambient, extensive tests showed no distortion of the pipe, showing that even with lengths contemplated for the St. Lawrence power project, an expansion joint would not be necessary.

Purchasing Specification

As part of the evaluation services, a purchasing specification was requested for the polyethylene tubing. This was based on CGSB 41-GP-5P with several changes. The highest degree of uniformity of dispersion of carbon black was specified because the pipe would be stored for a year or more out in the open. The diameter of coiling was increased substantially. Instead of two permissible failures in environmental cracking out of six in three hours, only one under eight hours was permitted. In view of the importance of the application and the very long life desired, it was felt that the highest quality should be obtained.

About two-thirds of a mile of ¾-inch polyethylene pipe went into the Manitou Generating Station, 1-¼ miles in the Pumped Storage at Niagara and about five miles in the St. Lawrence Power Project.

(2) Polyethylene Pipe for Electrical Ducts

This application was in connection with the square-mile artificial lake created at Queenston at what is called the Pumping Generating Station. The layout of this station shows a requirement of 36 runs of duct, 40 feet long and 4 inches in diameter. These ducts are to accommodate lead-sheathed high-voltage cables of 2.6 inches in diameter, the leads running from the generators to the 15-kv switchgear.

The shortest route for the duct is through structural concrete, the run containing two bends of seven-foot radius and a change in configuration. The normal duct material is bitumen-impregnated fiber. Neither of the bends required can be made with factory-made units. It was originally planned, therefore, to use short lengths of fiber duct with deflection couplings. It was apparent that considerable difficulty would be presented in installation due to the weakness of the fiber duct and the difficulty of holding it together and in place during mass concrete pouring.

The project engineer asked whether "any of the plastic materials available in pipe form would be a suitable substitute (!) for the fiber duct". After our experience with polyethylene for piezometer tubing, this material appeared suitable for the application but, as before, questions arose related to this particular one. Could it be bent in the field under field conditions by the workmen? Would it distort seriously during bending?

Will there be any serious consequences when the cable runs hot? What about the lead-sheath temperature when a fault (short-circuit) occurs between conductor and the lead sheath? Previous experience provided us with answers to the choice of cable-pulling lubricant and field handling problems.

A 20-foot length of 4-inch polyethylene pipe with 0.4 inch wall was used for bending tests in the field. Bends made cold and by low-pressure steam were completely satisfactory. Then there followed some rough-handling tests of deliberate violence of the type that the fiber duct could never withstand. The ability of the pipe to "take it" made a strong impression on the field construction crew.

When a fault occurs in the cable and the current flows from the conductor to the lead sheath to ground, it is expected that the lead sheath temperature will rise appreciably above normal. This is because the cross-sectional area of the lead (in this application) is considerably less than the copper as is also its electrical conductivity. Knowing the fault current it is not difficult to calculate the final lead temperature which, in this case, was only a few degrees and therefore negligible. (In other cases, however, lead sheath temperatures were calculated to rise to 180 C° or 356 F°).

Many of these duct runs have now been installed. A comparison of material cost shows that the polyethylene is approximately nine times more costly per foot than the equivalent size of fiber duct. The labour cost, however, was drastically lower than for fiber. In addition, because of the brittleness of the fiber duct and the tendency to get blocked with concrete, it had been planned to put in 50 per cent spares. The polyethylene, being leakproof and more rugged, permitted either the complete omission of spares, or one spare for each six ducts required. The over-all saving, therefore, is appreciable.

Appendix I

Environments used to Evaluate Thermoplastic Pipe

The standard reagents are of chemically-pure grade.

(a) Solution of pH 13:	5.6 grams potassium hydroxide per litre. This is 0.1 mol/1. At 140 F° the pH of this solution is about 12.
(b) Solution of pH 9:	0.568 grams sodium borate per litre. ($Na_2B_4O_7.10H_2O$.)
(c) Distilled water:	pH usually 5.5 at room temperature.
(d) Solution of pH 3:	0.0365 grams hydrochloric acid per litre. 0.01 ml hydrochloric acid (S.G. 1.19) per litre, or 0.001 mol/1.
(e) Solution of pH 3:	3.0 grams glacial acetic acid (S.G. 1.05) per litre, or 0.05 mol/1.
(f) Solution of pH 2.7:	0.098 grams sulphuric acid (S.G. 1.84) per litre, or 0.001 mol/1.
(g) Detergent lubricating oil:	MIL Supplement 2 oil, with basic detergent.
(h) New transformer oil:	Of known interfacial tension and neutralization value, e. g., ASTM D1040-49T.
(i) Used transformer oil:	Of neutralization value not less than 0.5 and up to 1.0.

Brazing Fundamentals . . .

(Continued from Page 26)

Repairs to Plastic Dies

Repairs are often required on dies because of cracking, chipping, or pits. These sections could be brazed at the low temperatures and the voids built up with the brazing material could be polished off, thereby eliminating the necessity of building a new section, losing production.

Many times, critical operating parts of the molding equipment break, and replacement might take several days. The broken part can be repaired in a matter of hours by brazing the sections together and re-heat treating to the original specification.

In brazing, as demonstrated by the capillary action at the formula, the clearance at the joint is of extreme importance. Copper, which has excellent weldability, requires only a press fit to .002" clearance. Other brazing alloys whose surface tension is higher require clearances of up to .010" in order to obtain maximum strength at the brazed joint.

Tests have shown that very little is sacrificed in tensile and shear strength on most metals brazed with copper when brazed with the proper clearance.

A general curve for most brazed joints with regards to clearance for all brazing alloys follows the general curve which is shown in Figure 3.

As indicated, the joint clearance has a direct bearing on the mechanical strength that may be expected from any brazed joint. If clearances less than those recommended are used, then the mechanical strength of a joint will fall off appreciably due to voids.

Larger clearances will, of course, approach the strength of the braze material and the advantage of the alloying phenomena between the braze metal and the parent metal will be lost.

Rule of Thumb

A good rule of thumb to use in designing sections for brazing is to keep the brazed joint under compression as much as possible.

This, of course, indicates that an extremely tight fit is desirable. However, this great shear strength is obtained only by longer time at temperature and the great wettability or low surface tension of the copper. Therefore, for uniform quality and satisfactory brazing without the possibility of voids, press fits are generally recommended for copper.

Brazing alloys are obtainable in many forms, such as wire, rings, powder, paste, sheet, flat washers and many other special forms. Rings, for instance, are readily available in many diameters, with varying wire diameters.

The effect of time affects the tensile strength of a braze in the general pattern similar to that of Figure 3. The peak strength occurs between 25 and 35 minutes.

Many of the plastic dies are made of specially alloyed low carbon steels which are subsequently carburized to produce the desired surface hardness. This material may be brazed either before or after carburizing. My recommendation would be to carburize after brazing.

The big reason why brazing has been on an upswing in almost every major field, is because of the wide range of applications and uses to which it may be applied. Newer techniques, technical advances and newly developed equipment being introduced each year will further increase the use of brazing in the future.

JANUARY
1957

Plastiatrics

DOW'S CLINICAL APPROACH TO HEALTHY PLASTICS APPLICATION

HIGH SPEED MOLDING OF THIN WALL CONTAINERS

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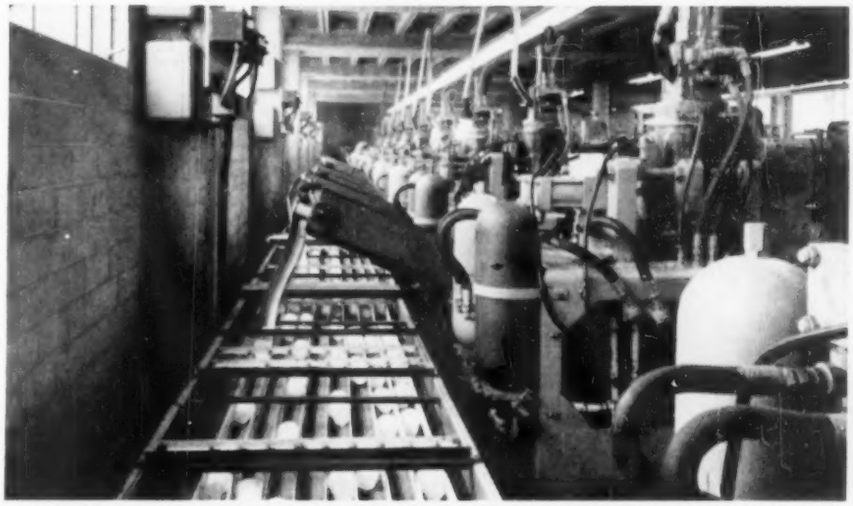

AUTOMATION OF THIS INJECTION MOLDING PRODUCTION LINE FOR VENDING MACHINE CUPS IS A MILESTONE IN THE DYNAMIC GROWTH OF PLASTICS MANUFACTURING.

WRITE FOR TECHNICAL BULLETIN

For a more detailed report on the molding of thin-walled containers, ask for Plastics Technical Service bulletin—"The Technology of Injection Molding, VIII, Thin Sections". Look for the findings of continuing Plastiatrics research in these pages regularly. THE DOW CHEMICAL COMPANY, Midland, Michigan . . . Plastics Sales Department PL 436D.

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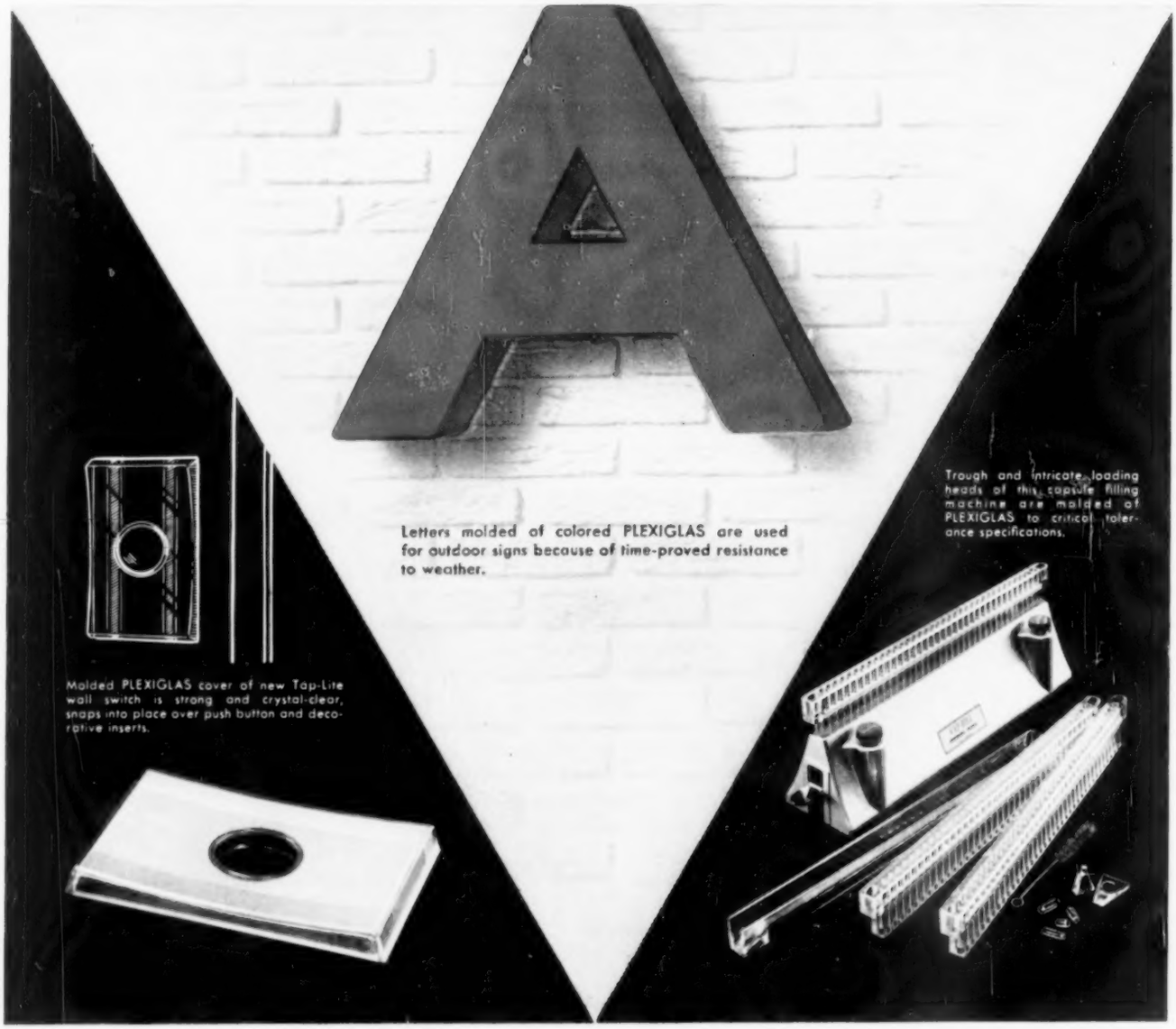
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Action— By Your National Organization

"The objects of the Society shall be to promote in all lawful ways the Arts, Sciences, and Engineering Practices and Standards connected with the utilization of plastics."

SPE Publishes Technical Volume "Quality Control For Plastics Engineers"

SPE, since its inception, has been committed to the goal of disseminating technical information on plastics. This it has done through the media of annual technical conferences and the SPE Journal, as well as the numerous local section meetings. Now SPE has launched further into two other means of communication: (1) the special technical conferences, and (2) the publication of technical volumes.

The growth of the Society which has made possible the establishment of committees and task forces suitably manned to take on responsibilities such as those entailed in publishing books can be expected to continue at an even more rapidly accelerating rate due to the appearance of such technical volumes. This in turn should make it more possible to produce much needed technical literature on all aspects of plastics technology. With publication of such literature comes the natural tendency to organize data and with this should come a more realistic approach to the solution of the many problems which are extant today in our industry.

The appearance of the first in the series of technical volumes should thus be hailed as the beginning of a new era in the history of SPE and the plastics world. Just as in other activities of our Society, the credit for this symbol of growth must be given to many individuals. Actually, we can date back to 1948 when J. H. DuBois, then President of SPE, set up the first committee on quality control. Members of this committee groped hopefully for some means by which they could perform worthwhile service for the Society. When the present chairman of the committee was appointed, it began to seem possible to carry out the dream of publishing a useful book on this subject. Dr. Larry Deming with the cooperation of many others, including the members of his committee, began a series of articles on various phases of quality control which could be applied to the plastics industry. Don Hoffman organized this committee into a project task force in the professional activities committee. Peter Simmons and his Publications Committee cooperated at the time it became necessary to consider publication details. The list of names can be continued but rather than inadvertently omit any, it is better to state that the present Volume I of SPE's technical volume series is a true cooperative effort of many people. In announcing the publication of Volume I of this series, it is with real pride that I, as President of SPE during 1956, can take this means of announcing this very important development in the growth of our Society.

Though we may take pride in achieving this first indication of success in a new field of endeavor, it is with real humility that we make available to our industry the work which may be instrumental in achieving the high standards of performance which are essential if our industry is to continue in the important position which it has already attained. As members of our Society and our industry make use of the information available in this volume we shall undoubtedly find more and more need for additions and possible revisions to this work. We do not intend to delude ourselves into thinking that now the job has been completed. Instead, we look forward to comments, criticisms and suggestions as to how this important work can be made more effective.

Jerome Formo

National President, SPE

"Quality Control for Plastics Engineers" is volume one of a series of books on plastics engineering to be published by SPE. Other volumes are in the process of being written, and will be announced in the months to come.

"Quality Control for Plastics Engineers," edited by L. M. Deming, will first be available on January 16, 1957, when it will be introduced at the Business Luncheon of the 13th Technical Conference. The book will contain about 180 pages and will be priced in line with similar technical books. Publisher is Reinhold Publishing Corp, 430 Park Ave., New York City.

Contributors to the text include Harold Gulde, R. S. Fay, Malcolm Young, John A. Kudlock, Dorian Shainin, D. C. Dague, Leonard A. Seder, Gilbert L. Peakes, John Hinchen and Edwin C. Harrington, Jr.

Program

15 Years of Plastics Progress

The Thirteenth Annual SPE Technical Conference

JANUARY 16-18, 1957 — HOTEL JEFFERSON — ST. LOUIS

REGISTRATION
MEZZANINE

Tuesday	1:00 p.m. to 9:00 p.m.
Wednesday	9:00 a.m. to 5:00 p.m.
Thursday	9:00 a.m. to 5:00 p.m.
Friday	9:00 a.m. to 12:00 noon

TUESDAY, JANUARY 15, 1957

Informal Smoker 8:00 p.m. Ivory Room
Section President's Meeting 8:30 p.m.

WEDNESDAY, JANUARY 16, 1957
Invocation and Official Opening of Conference
9:00 a.m.

WEDNESDAY, JANUARY 16, 1957
Morning Sessions
9:30 a.m. to 12:00 noon

Session I — Ivory Room

ATOMIC
Moderator—David Ballantine, Brookhaven Laboratories

Some Vital Roles of Plastics in High Energy Nuclear Research—*J. O. Turner, University of California*

Application of a Flexible Plastic for Contamination Control—*H. A. Moulthrop, General Electric Company Hanford Atomic Products Operation*

The Permeability of the Polyethylenes to Gases and Vapors—*V. L. Stannett, State University of New York*

The Corrosivities of Plastics and Rubbers—*H. A. Perry, Jr., A. M. Chreitzberg, I. Silver, H. E. Matthews, Jr., U. S. Naval Ordnance*

Session II — Gold Room

DESIGN
Moderator—Dr. R. B. Akin, E. I. duPont deNemours & Co.

Practical Methods for Controlling the Effect of Moisture on Molded Nylon—*H. B. Happoldt, A. J. Cheney, E. M. Lacey, E. I. duPont deNemours & Co.*

Plastics—An Answer for Industrial Design—*R. Hughes, Emerson Electric Mfg. Co.*

From Appearance Design to Prototype Model—*Edward Ferrari, General Electric Company*

Can Performance Tests be Developed for Finished Molded Articles—*R. A. McCarthy, Monsanto Chemical Co.*

Session III — Crystal Room

TOOLING AND MACHINERY
Moderator—Islyn Thomas, Newark Die

Continuous Winding Machinery for Plastic Film and Sheeting—*John E. Nordgren, The Black-Clawson Co., Inc.*

The Importance of Mold Rigidity in Injection Molding—*R. N. Farris, The Dow Chemical Company*

Materials, Tooling and Machines for Injection Molded Packaging—*B. Nathanson, Monsanto Chemical Company*

The Engineering of Molds Utilizing Electroformed Cavities—*W. J. B. Stokes, III, Electromold Corp.*

CONFERENCE LUNCHEON
12:00 noon—Boulevard Room
LUNCHEON SPEAKER
Hon. Raymond Tucker
Mayor, City of St. Louis

WEDNESDAY, JANUARY 16, 1957
Afternoon Sessions
2:00 to 4:30 p.m.

Session I — Ivory Room

EXTRUSION I
Moderator—Clem Young, Crescent Plastics

Factors Affecting Quality in Polyethylene Extrusions—*B. H. Maddock, Bakelite Co.*

Applications of Extrusion Theory—*R. E. Colwell, Monsanto Chemical Co.*

Valved Extrusion—*E. C. Bernhardt, E. I. duPont deNemours & Co.*

Effect of Blow-up Ratio on Blown Polyethylene Film Properties—*C. G. Kucher, Spencer Chemical Co.*

Session II — 2:00 to 4:30 p.m. — Gold Room

INJECTION MOLDING I
Moderator—Dr. Louis F. Rahm, Princeton University

The Molding of Linear Type Polyethylene—*F. J. Rielly, Celanese Corp. of America*

Injection Speed Considerations—*L. E. Tallman, O. G. Maxson, Dow Chemical Co.*

Uniformity Considerations for Plastic Stock Temperature in Injection Molding—*A. L. Bird, Joe Eveland, Dow Chemical Co., Plastics Tech. Serv.*

Heat Resistant Polymethystyrene Thermoplastic—*J. P. Melchore, American Cyanamid Co.*

Session III — Crystal Room

2:00 to 4:30 p.m.

FOAMS

Moderator—Arnold Varner, General Electric Co.

Polystyrene Foam—A Low Density Molding Material—*D. L. Graham, Dow Chemical Co., Plastics Tech. Serv.*

Polystyrene—A Versatile Foaming Material—*R. N. Kennedy, G. R. Franson, Dow Chemical Co., Plastics Tech. Serv.*

Plastics Sandwich Construction—*G. D. Miller, H. J. Waite, Dow Chemical Co., Plastics Tech. Serv.*

Use and Application of Isocyanate Foams—*Benjamin S. Collins, Nopco Chemical Co.*

Session IV — Ivory Room

8:15 p.m. to 9:30 p.m.

EDUCATIONAL SYMPOSIUM

Moderator—R. C. Bartlett, Natvar Corp.

Engineering Manpower Problems

Supply and Training of Engineers—*Prof. L. E. Stout, Washington University*

Supply and Training of Technicians—*Prof. C. H. Stephans, Newark College of Eng.*

Engineers Needed in Manufacturing—*George M. Prall, Western Textile Products*

Procurement of Engineers—*Robert W. Smith, Emerson Electric Mfg. Co.*

9:45 to 10:30 p.m.

Application of Engineering Design to Plastics—*E. I. duPont deNemours & Co.*

THURSDAY, JANUARY 17, 1957

Morning Sessions
9:30 a.m. to 12:00 noon

Session I — Gold Room

INJECTION MOLDING II

Moderator—Gordon Thayer, Dow Chemical Co.

Pressure Measurement in Injection Molding—Use of Ejector Pins—*P. D. Kohl, E. I. duPont deNemours & Co.*

Hydraulic System and Its Relation to Polymer Flow Through an Injection Molding Machine—*O. M. Hahn, J. B. Broussard, E. I. duPont deNemours & Co.*

A Discussion of Bulk Compressibility of Polymers and Effect of this Compressibility on the Flow Properties—*S. Matsuoka, Bryce Maxwell, Princeton University.*

New Gating for Acrylics—*J. F. Moore, Rohm and Haas Co.*

Session II — Ivory Room

9:00 a.m. to 12:00 noon

EXTRUSION II

Moderator—George Prall, Western Textile Products

Shape Extrusion Studies of Nylon Resin—*K. G. Toll, E. I. duPont deNemours & Co.*

Rigid Thermoplastics Piping—*Howard H. Irvin, Marbon Chemical Co.*

Problems in the Selection of Extrusion Screws—*Robert Sackett, Monsanto Chemical Co.*

Nylon 6 Extrusion—*R. L. Hughes, Spencer Chemical Co.*

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Session III — Crystal Room

9:00 a.m. to 12:00 noon

APPLICATIONS

Moderator—Dr. Albert Lightbody, U.S. Naval Ordnance

Vinyl-Clad Steel—*Glenn E. Wintermute, Arvin Industries, Inc.*

A Method of Testing Quality of Phonograph Records—*N. J. Gifford, P. C. Woodland, Dow Chemical Co.*

New Fabrication Techniques for Flush Circuitry—*E. L. Ditz, P. E. Ritt, Melpar, Inc.*

Stability of Nylon Parts in Business Machines—*Byron W. Nelson, National Cash Register Co.*

12:00 Noon
Past President's Luncheon—Room 6

THURSDAY, JANUARY 17, 1957

Afternoon Sessions
2:00 to 4:30 P.M.

Session I — Gold Room

REINFORCED PLASTICS I

Moderator—R. J. Savage, Celanese Corp.

Glass Flake Laminate—*G. Ruggers, Picatinny Arsenal*

The Problems of Fittings to Match the Performance of High Pressure Reinforced Plastic Pipe—*H. D. Boggs, The Fibercast Corp.*

Plastic Compressor Rotor Blades for Turbo Jet Engines—*John F. Kulp, General Electric Co.*

Molding Thick Glass—Reinforced Polyester Laminates—*F. Claudi-Magnussen, Hooker Electrochemical Co.*

No Wait At Breakfast

—The Boulevard Room at the Jefferson—has been set aside during breakfast for **SPE members only.** This restaurant seats 550, and is a **10-second** walk from the meeting rooms!

REMEMBER — for fast, no-wait service at breakfast, go to the **BOULEVARD ROOM** — it's **OURS EXCLUSIVELY!**

Session II — Crystal Room

2:00 to 4:30 p.m.

INSTRUMENTATION

Moderator—Don C. Walley, K-S-H Plastics

Watt Density and Thermocouple Location Studies on the Injection Molding Heater—*R. B. McKee, R. B. Dahl, Dow Chemical Co.*

Pressure Control for Injection Molding Machines—*C. E. Beyer, Dow Chemical Co.*

Platen Press Temperature Control—*J. C. Stansel, General Electric Co.*

Advantages of Dual Thermocouples in Injection Cylinders and Extruder Barrels—*Richard K. West, West Instrument Corp.*

Behavior of Materials Under Control—*H. H. Kieckheffer, Barber-Coleman Co.*

Session III — Ivory Room

2:00 to 4:30 p.m.

COMPRESSION MOLDING

Moderator—E. E. Woodman, Hooker Electrochemical Co.

The Use of Alkyd Molding Compounds in Electrical and Electronic Applications—*James J. Moylan, Barrett Division, Allied Chemical & Dye Corp.*

Advanced Tooling Techniques for Molding High Impact Thermosetting Materials—*Edwin Keusch, The Fiberite Corp.*

Synthetic Fiber Reinforcement of Thermosetting Resin Laminates—*John G. Green, Jr., E. I. duPont deNemours & Co.*

A Discussion on a Fully Automatic Transfer Molding Machine—*John J. Hull, Hull-Standard Corp.*

Molding of Tetrafluorethylene Resin—*L. T. Bunn, F. M. Chapman, E. I. duPont deNemours & Co.*

Session IV — Meeting Room I

2:00 to 4:30 p.m.

RESEARCH SYMPOSIUM

Moderator—Eli Haddad, Monsanto Chemical Co.

Rheology of Thermoplastic Substances

Heat Generation and Expansion Effects in the Rheology and Molding of Plastics—*H. L. Toor, Carnegie Institute of Technology*

Determination of the Flow Properties of Thermoplastic Melts—A Review of Instruments and Methods — *James McKelvey, Johns Hopkins University*

The Photographic Study of Flow of Molten Polyethylene and Capillaries—*J. P. Tordella, E. I. duPont deNemours & Co.*

Classification and Interpretation of Flow Data—*R. E. Colwell, Monsanto Chemical Co.*

Flow Behavior and Turbulence in Polyethylene—*R. F. Westover, Bell Telephone Laboratories*

COCKTAIL PARTY AND PRESIDENT'S RECEPTION

6:00 p.m. — Ivory Room

BANQUET

7:00 p.m. — Gold Room

BANQUET SPEAKER — JOSEPH HOLLAND,
Pevely Dairy Co.

Past Imperfect — Future Tense

FRIDAY, JANUARY 18, 1957

Morning Sessions

9:00 a.m. to 12:00 noon

Session I — Ivory Room

POLYETHYLENE

Moderator—John Howard, Bell Laboratories

Dimensional Stability of Linear Polyethylene—*R. W. Miler, W. C. Sager, Dow Chemical Co.*

Linear Polyethylene as a Melt Spun Fiber, *T. C. Broadwell, A. T. Widiger, G. H. Youse, Dow Chemical Co.*

Property—Structure Relationships in Polyethylene — *H. M. Spurlin, W. O. Bracken, Hercules Powder Co.*

A Method of Evaluation of Polyethylene Molding Compounds—*C. S. Imig, K. Kaufman, Spencer Chemical Co.*

Session II — Gold Room

9:00 a.m. to 12:00 noon

REINFORCED PLASTICS II

Moderator—Ralph Sonneborn, Owens-Corning

Recent Advancement in the Technology of High Temperature Resin—Glass Systems—*S. G. Salzinger, Coast Mfg. Co.*

Synthetic Fibers in Formable Acrylic Sheet—*Dale E. Jackson, E. I. duPont deNemours & Co.*

Extreme Strength Reinforced Plastics Film Systems—*John Bjorksten, Risto P. Lappalo, Bjorksten Research Laboratories*

Estimating in Reinforced Plastics—*Frank W. Sheffler, Lunn Laminates, Inc.*

Session III — Crystal Room

9:00 a.m. to 12:00 noon

EPOXIES

Moderator—Jerome L. Formo, Minneapolis Honeywell

Epoxy Encapsulation of Transistor Flip-Flops—*R. F. Marshall, P. E. Ritt, Melpar, Inc.*

Polysulfide Liquid Polymer-Epoxy Resin Compounds in Plastic Tooling Applications—*Alan J. Breslau, Earl H. Sorg, Thiokol Chemical Corp.*

Manufacturing Considerations Associated with Encapsulating, Embedment and Potting Processes—*C. A. Harper, Westinghouse Electric Corp.*

Epoxy Foams—*Luther Bolstad, Minneapolis Honeywell*

LADIES' PROGRAM
WEDNESDAY, JANUARY 16, 1957

Breakfast — 9:30 a.m. — Room 6

Style Show — 3:00 p.m. — Scruggs-Vandervoort—Tea Room

11:00 p.m.

Television Interviews (Ladies and Men) on Chuck Norman's "Nightcap"—Station KTVI

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THURSDAY, JANUARY 17, 1957

9:30 a.m.

Breakfast — Room 6

10:00 a.m.

Non-Technical Session—"Plastics in the Home"—*Virginia Echols, Dow Chemical Co.*

Cocktail Party — 6:00 p.m. — Ivory Room

Banquet — 7:00 p.m. — Gold Room

11:00 p.m.

Television Interviews (Ladies and Men) on Chuck Norman's "Nightcap"—Station KTVI

* ____ *

FRIDAY, JANUARY 18, 1957

9:30 a.m.

Breakfast — Room 6

NEWS *of the industry*

Polyethylene Tubing

Food Film, Inc., P.O. Box 258, Caldwell, New Jersey announces food film "Steripol," a sterilizable polyethylene tubing produced in the same widths as food film "standard" poly tubing of 2" through 4½" and gauges from ¾ mil (.00075") to 2 mil (.002").

Suggested uses are for frozen foods to be cooked in the package, packaging of drugs and of materials or instruments which would be sterilized in the package. "Steripol" tubing is much less permeable than conventional polyethylenes to carbon dioxide, oxygen and water. Transparent, good burst strength, heat sealable, this new tubing should find many new uses because of its ability to withstand boiling.

This tubing is made by patented methods and machines developed by Milo R. Gerow, Montclair, New Jersey and licensed to Food Film, Inc.

Board Surfacing

Two new board surfacing resins are now available in commercial quantities from the Plastics and Resins Division of American Cyanamid Company. These resins, CYZAC 2247 and CYZAC 2352, have proved successful in experimental usage during the past year in plywood-pressure application of protective plastic surfaces directly to particle board and plywood.

CYZAC Resin 2247 is recommended for impregnating print-grade laminating papers. CYZAC 2352 is recommended for impregnating overlay-grade laminating papers.

Printed laminating papers impregnated with CYZAC Resin 2247 are used in conjunction with CYZAC 2352 to produce decorative surfaced hardboard for use as wall panels, door panels, cabinets, various do-it yourself applications, low-cost furniture, and TV cabinets.

Technical data may be secured from American Cyanamid Company, Plastics and Resins Division, 30 Rockefeller Plaza, New York 20, New York.

Sales Manager Named

Automatic Molding Machine Company of Los Angeles, Calif., makers of Automold high-speed, fully-automatic compression molding machines, announce the appointment of George B. Croft as Western Sales Manager, for all states west of the Mississippi.

Finishing Molds

At a convention of the Swedish Plastics Association held in Stockholm, October 29 to 31, R. J. Swan, Technical Manager, Engis Limited, London, delivered an illustrated address on the use of diamond compounds for finishing molds in the plastic industry.

Reprints of the complete address are available from Engis Equipment Co., 431 S. Dearborn St., Chicago 5, Illinois, of which Engis Limited is an affiliate.

New Plant Addition

Charles W. Kleiderer, newly-elected executive vice-president of Penn-Plastics Corp. and its subsidiary, Penn-Plastics Manufacturing Co., announced that ground has been broken for a new addition to the firm's plant in Glenside, Pa.

The added wing will be used to house Penn-Plastics' rapidly-expanding injection molding facilities and to allow for enlarging the finishing department. The space freed by moving these operations to the new area will allow for additional compression and transfer molding machinery to be installed.

Plant Begins Production

Escambia Chemical Corporation's new polyvinyl chloride resins plant will begin production next month with a molecular weight range of specially designed, easy processing, general purpose PVC resins for use in the calendering, extrusion and molding industries.

These new resins were developed in Escambia's research and pilot plant facilities at Cambridge and Newton, Massachusetts. One of the outstanding characteristics of these resins is improved heat stability with its advantages in quality control and processing.

General headquarters and sales offices of the company are at 261 Madison Avenue, New York.

Two Appointments Announced

Vlcheck Tool announces the appointment of Mr. Donald R. Butler to the position of Manager of the Plastics Division. He is a graduate of Case Institute of Technology with a degree in Mechanical Engineering. Also they announce the appointment of Mr. Carl Towne to the position of Asst. Superintendent of Plastics Production.

Men In The News

E. Russell Ashley

E. Russell Ashley, elected Executive Vice President and director of Electromold Corporation of Trenton, New Jersey manufacturers of electroformed molds for the plastic industry. Mr. Ashley was founder and former President of Ashley-McCormick Company of Bridgeton, New Jersey and was active as an officer in the National Stationers and Office Equipment Association.

Solomon Elmasion

Solomon Elmasion, formerly plant chemist at Plastic Film Corp. has taken over as President and Treasurer of Floatex, Inc.

At the present time Floatex is a processor of unicellular vinyl foam material in cylindrical shapes up to 5" in diameter, and 70" lengths. They hope to be in a position to offer unicellular sheet stock from ⅜" thickness up, by 70" width, in the very near future.

G. L. Pitzer

G. L. Pitzer has been appointed Vice-President—Production, of Bakelite Company, according to G. C. Miller, President of this Division of Union Carbide and Carbon Corporation.

D. W. Weber

Mr. D. W. Weber, who has been associated with Southern Plastics Company for eleven years, has been appointed Chief Engineer and Mechanical Superintendent. Mr. E. M. Staub, who has been associated with this company also for eleven years, has been appointed Superintendent of the Extrusion Department.

James E. Shand

The appointment of James E. Shand as Assistant Manager, Chemical Sales, effective August 1, 1956, has been announced by Barrett Division, Allied Chemical & Dye Corporation of New York.

Mr. Shand entered Barrett's employ in 1946 as a member of its technical sales service group, later serving as special representative. He was promoted to Assistant Sales Manager in 1954 and named assistant to Leon W. Miller, Manager, Chemical Sales, last March.

Horton Conrad

Gering Products, Inc., suppliers of plastic raw materials, of Kenilworth, New Jersey have appointed Horton Conrad, Director of Sales, a new position. Mr. Conrad will direct the overall sales activities of all divisions.

Industrial Literature

Teflon Report

The versatility of Teflon as a dry lubricant and preservative for metals has been demonstrated in Marine Corps tests of weapons coated with the material. A report of the tests has just been released to industry through the Office of Technical Services, U.S. Department of Commerce.

This interim report, the first on a projected series of tests, is PB 121286 Teflon, C. A. Roberts, Marine Corps Development Center, Apr. 1955. It contains 46 pages, price $1.25. A report of Navy tests with Teflon previously released through OTS is PB 121161 Thin Films of Polytetrafluoroethylene Resin (Teflon) as Lubricants and Preservative Coatings for Metals, Naval Research Laboratory, June 1956. This volume contains 32 pages, price $1. Both reports may be ordered from OTS, U.S. Department of Commerce, Washington 25.

Dinnerware Standard

A Recommended Commercial Standard for Melamine Dinnerware (Alpha-Cellulose-Filled) for Household Use, has been circulated to the industry for written acceptance by the Commodity Standards Division of the U.S. Department of Commerce.

Copies of the Recommended Commercial Standard for Melamine Dinnerware (Alpha-Cellulose-Filled) for Household Use, TS-5340, may be obtained free by addressing a request to F. W. Reynolds, Commodity Standards Division, U.S. Department of Commerce, Washington 25, D.C.

Reinforced Plastics Bibliography

A second supplement to the Bibliography on Reinforced Plastics, consisting of 10 pages of information on glass fibre and asbestos fibre reinforced plastics has been compiled by the British Plastics Federation and is available on application to the Federation offices at 47-48 Piccadilly, London, W.1.

The original Bibliography, which costs one guinea, inclusive of the supplements, can be ordered direct from the Federation.

Copies of the very comprehensive Buyers' Guide to Plastics Materials and Machinery and Equipment can still be obtained from the Federation offices, price 2s.6d. (post free, United Kingdom).

Shell Molding Process

"Plaskon Resins for Shell Molding," a new 32 page illustrated booklet has just been issued by Barrett Division, Allied Chemical & Dye Corporation, 40 Rector Street, New York 6, N. Y.

The book describes the shell molding process for casting metals with particular emphasis on the foundryman's problems.

A copy of the booklet may be obtained directly, without charge, from Barrett Division, Allied Chemical & Dye Corp., 40 Rector Street, New York 6, New York.

Fluoro-Silicone Elastomers

DEVELOPMENT OF FLUORO-SILICONE ELASTOMERS, Part 2. P. Tarrant and G. W. Dyckes, Peninsular Chemresearch, Inc. for Wright Air Development Center. May 1956. 24 pages. 75 cents. (Order PB 121394 from OTS, U. S. Department of Commerce, Washington 25.) The effect of various initiators or catalysts on the addition reaction involving a single olefin-silane system was studied. Platinum supported on charcoal was found to give highest yields and allowed shorter reaction times and lower temperatures for the reaction. Compounds resulting from the addition of CF_2Br_2 and CF_2-BrCFClBr to vinyltrimethylsilane were made to undergo reactions involving loss of halogen. Properties of the new unsaturated compounds were determined.

New Alkoxyalkyl Acrylate

SYNTHETIC RUBBERS FROM CARBON-FLUORINE COMPOUNDS, Part 5. F. A. Bovey, Minnesota Mining and Manufacturing Co. for Wright Air Development Center. Apr. 1956. 67 pages. $1.75. (Order PB 121351 from OTS, U. S. Department of Commerce, Washington 25.) Fluorine-containing elastomers such as FBA (1, 1-dihydroperfluorobutyl acrylate), were prepared and investigated for possible use in fuels, lubricants and hydraulic fluids over the widest possible temperature range. One effective non-fluorinated plasticizer for poly-FBA was disclosed by experimentation. A new, economical type of alkoxyalkyl acrylate was developed.

Design Competition For Plastic Housewares

A two-year, full-tuition scholarship heads the list of five scholarship awards in the 1957 Design Competition for Plastic Housewares sponsored by Koppers Company, Inc., for the third consecutive year.

One-year scholarships will be awarded to first-prize winners in each of the four Competition classes, and the winner judged "Best-of-Competition" will be awarded the two-year scholarship.

Objective of the Competition, as in previous years, is to encourage and promote attractive, functional design and proper application of plastics in consumer products.

To Include "Original Products"

To this end, the scholarships will be granted in the name of the winning molder to a qualified college or university of his choice, for studies related to industrial design. The college or university will select the student to receive the scholarship.

An innovation in the 1957 Competition will be an award, at the judges' discretion, for the "most original" product in each class, if such a product is selected by them.

As was the case in previous Competitions, Honorable Mention awards will be made, also, in the four classifications, which are:

Class I—Polystyrene products for use with food.

Class II—Polyethylene products for use with food.

Class III—Polystyrene or polyethylene decorative products.

Class IV—Polystyrene or polyethylene home maintenance products.

Items entered in the Competition may be molded, extruded, or fabricated of either regular, modified or foamed polystyrene, or regular or modified polyethylene produced for sale as a housewares product.

Submission of Entries

A production sample of each entry to be judged must be received no later than February 15, 1957, and should be addressed to: Administration Committee, Koppers Design Competition, 1313 Koppers Building, Pittsburgh 19, Pa. Entry forms may be obtained from the same address. Winners will be announced at an Awards Banquet in Pittsburgh on April 2, 1957.

Entries in the Competition will be accepted from either the molder or proprietory manufacturer of the eligible product, and the awards will be given to the originator of the design.

Molding Nozzles Catalog

A 48-page catalog of injection molding machine nozzles is offered by Injection Molders Supply Co., 3514 Lee Road, Cleveland, Ohio.

Letters to the Editor

Materials Specifications Problems . . .

The SPE Journal
Security Bank Bldg.
Athens, Ohio

Modern manufacturing begins with product design; and inevitably, design progresses to the stage where materials must be specified. Instrumental in this latter activity is the product engineer or designer. He is the one who must select materials which will provide, at a minimum of expense, all of the necessary physical, chemical, mechanical and electrical properties. He also must define the selected materials so as to ensure delivery of the required properties at the desired cost.

The definition of a selected material is known as a specification; and in the problem of material specification, the work of the A. I. S. I., the S. A. E., N. E. M. A. and similar groups offers considerable assistance. However, because of its youth and meteoric development, the plastics industry can give little such help. Each user of plastics is reduced to doing without or developing his own general specifications for these materials.

Attempts at developing general specifications for plastics may lead the end-user to extensive testing of different materials in each of his products, or to reliance on his past experience, or to a combination of the two possibly flavored with advice from his parts molders and the basic raw material suppliers. In any event, no matter how satisfactory a self-developed general specification proves to be, the plastics end-user can rest assured that his general specification is unique. Because of human differences and the different needs of each manufacturer, every general specification written by an individual firm will display something different in scope, format or detailed requirements.

Even the individual ways of "identifying" plastic on a blueprint can vary widely. Of the several methods of plastic specification, four emerge as classic. These are:

1. generic name
2. trade designation
3. essential property
4. reference to a table of approved materials

Specification by **Generic Name**, e.g. "Phenolic Plastic," is more of a material description than a specification. Nonetheless, it is used and does have two advantages. It is simple and it requires a minimum of detailed product knowledge. In cases where wide variation in properties is acceptable, mere generic designation recommends itself.

However, specifying plastics in this broad, general manner leaves the precise choices up to vendors who may or may not be capable of intelligent selection. Furthermore, this method frequently allows considerable variation in the properties of parts received from several sources of supply, or from one source of supply but at different times. Such variations can present problems in assembly or in the performance of the finished product.

Use of generic names as a means of specification also ignores the price consideration. Cheaper grades of material may not always do the job expected while more expensive grades may not be economical. In this latter instance, properties that are not required will be purchased at a premium.

Specification by **Trade Designation**, e.g., "Resinox 1004" like generic name has the advantage of simplicity; and in addition, it is a method of rewarding raw material suppliers who have provided valuable technical or engineering advice. However, this manner of specification tends to perpetuate use of materials satisfactory in previous similar applications, i.e. full advantage of current developments will not always be taken.

Furthermore, specification by trade designation tends to freeze raw material supplies to a single source unless the words "or equivalent" are added. This device in turn has a disadvantage in that the definition of equivalency is left to Purchasing, Production, or possibly even to vendors, instead of being concentrated in the Design function where it properly belongs.

A final disadvantage of specifying by trade designation is the expense and difficulty of keeping blueprints current regarding trade nomenclature. This situation is particularly serious when a large number of parts is involved.

Specification by **Essential Property**, e.g. "Phenolic Plastic—Minimum Tensile Strength 7,500 p.s.i.", is a somewhat more exacting method of specification than the use of generic names; and being more exacting, it requires greater knowledge of both materials and the requirements of particular applications. Knowledge of the precise physical property that is critical in each case is requisite.

Specification by this method does not necessarily eliminate over-supplying; but in theory at least, it should eliminate undersupplying. To be effective in this latter regard, finished parts, not molded test specimens, should possess the required property.

Specification by **Reference to a Table of Approved Materials**, e.g. "Any Material From XYZ Corporation Approved List A", can be used to great advantage with proper implementation. Although this system is relatively complex, it ensures multiple sources of raw material supply; and by restricting material selection and specification to the proper groups, it eliminates variation in part performance caused by outside decisions. Furthermore, the scope of specification can be tailored to meet the individual manufacturer's requirements.

Basic to the use of this method of specification is the development of a technical staff responsible for writing the general specifications, testing materials and providing materials advice. This staff must be highly competent because specifications by this method are only as good as the material tables themselves. Unless the tables are kept current, new material developments can be ignored; and unless the tables are used with intelligence, faulty specifications can be made.

Since any reference tables which may be developed are peculiar to the needs of a single manufacturer, the plastic molders involved must be educated to use the tables in their own purchasing and production operations. This education problem can be partially overcome by basing tables on the established military specifications which are familiar to molders and raw material suppliers alike. However, these specifications cover only a few of the available plastics and are limited primarily to certain electrical and mechanical applications. Hence, they are too narrow in scope for general use by the average manufacturer; and this narrowness minimizes their potential effectiveness in overcoming the education problem.

Specification by reference to a table of approved materials can be designed to reward the cooperation of particular raw material suppliers or molders in cases where that is desired. The respective devices are "preferred product" and "preferred source" notations in the approved lists.

(Continued on Page 44)

THE INJECTION molderscope

A. R. Morse
Injection Molders' Supply Co.

Since January 1951 the Injection Molderscope has appeared in each of the 61 issues of SPE Journal. The series ran for six full years and ends with this issue. Though an occasional issue would cause a storm, still Ren Morse called his shots as he honestly saw them, and wrote a column which was probably the most widely read of its kind. To Ren Morse—for six years of hard work—thank you!

In place of the Injection Molderscope the SPE Journal will introduce a new feature devoted to the problems of injection molding, starting with the February issue.

Farewell to the Molderscope

The Injection Molderscope had its inception 6 years ago when our editor, Dr. Jesse Day, was searching for more vigorously written, interesting material. The times have changed, and I therefore feel the time has come to say farewell. I personally always regarded the Injection Molderscope as a contribution to help the SPE along its way.

As any institution grows, it becomes more formal, and the sometimes undignified way I slashed around often caused many people to say that this fellow is hurting his own business, by facing up to the facts as he sees them. These people are undoubtedly right.

A reader survey once showed that some 67% of the Journal readers read the Molderscope although only about 20% of them were injection molders! But the initial purpose of the column has now been served. The SPE is no longer facing deficits from a series of unsuccessful years. The SPE is on its way, and the SPE Journal is achieving maturity, and can no longer afford the naive but stimulating approach I purposely used in writing the column. So far as I know except for space limitations, Dr. Day never blue penciled my column, and what you read was the **only** editorial matter in the entire plastic industry that was completely unemasculated. Such absolute frankness with which I faced up to the various topics stirred up a lot of smoke. On one occasion an article was retyped and made to say something entirely different just to discredit the author and the Journal because we had scooped the trade on a story.

The problem of documenting each column has been monumental, for we had to have pretty solid ground to stand on, and my attorney has insisted on dates, names and places, to prove all the major points I covered. At any rate, the time has come to say goodby. I want to thank all those who wrote me or the Journal favorably about the column. And to those who complained about it, I would say, I hope they will be inspired to do much more for SPE than I have been able to do in these columns, and so eclipse with their own more constructive contributions the memory of the Injection Molderscope!

Letters (from page 43)

Even assuming the existence of general specifications and an intelligently selected manner of specifying, the problem of plastic material specification is not completely solved. The triangular nature of utilizing plastics must be taken into consideration. Performance requirements must be compromised not only in light of what the basic raw material suppliers can offer but also in view of what the molder is capable of producing. Somewhere in each individual specification, the effects of molding and mold design on the properties of the finished part must be equated with molding costs, the design of the part and the nature of the material called for. An effective blueprint specification will, therefore, include a notation of the type of molding required and or of gate and runner location relative to certain axes of the part.

Where the performance of a part can be influenced by the purity of the raw material, requirements regarding the use of virgin materials should also be affixed.

To be effective, any specification program must be like the wolf in Little Red Riding Hood, that is, it must have teeth. These teeth are readily supplied by an incoming quality control program. Here again, however, the plastics end-user must struggle to develop test methods largely without outside help. The properties of plastic materials have not yet been satisfactorily correlated with a single property. Plastics cannot be specified or accepted on the basis of hardness, as can steel, for example. Furthermore, the value of data on test specimens as a determinant of finished part performance is questionable.

To develop (1) effective general specifications, (2) appropriate methods of specification and (3) rapid, realistic acceptance testing procedures, in short, to do the sort of job that the task requires, is a monumental chore for any single manufacturer. Even if the resources of a single manufacturer were adequate to the task, the economics of the work would certainly discourage him.

Therefore, it becomes the responsibility of the plastics industry and the duty of the S.P.E. to do for all plastics users what they cannot do for themselves. The S.P.E. must launch a solidly founded program to develop comprehensive general specifications for all commercially available plastics.

Sincerely,
John S. Fosse

Materials Engineer
Sunbeam Corporation
Chicago, Illinois

ARGENTINA

PLASTICOS

July, Aug., 1956

Abstracter: John B. Ballard

THE PERMANENT EXHIBIT IS NEARLY COMPLETE

Permanent exhibits of plastic products will be installed in the building of the Argentine Chamber of the Plastic Industry. Exhibit spaces have been leased by 10 suppliers of materials and 27 molders and fabricators.

GERMANY

KUNSTSTOFFE

Oct., 1956

Abstracter: Anne Schwend

THE INFRA-RED SPECTRUM OF PLASTICS, RESINS AND THEIR DERIVATIVES USED FOR THEIR IDENTIFICATION — Dieter Hummel

Since infra-red spectroscopic methods can not only be used for the identification of high-molecular structures but for plastics in general and lacquers as well, theoretical and practical reasons for the limitation of such identification methods are discussed. It is considered essential that a systematic collection of the spectra of plastics, lacquer bases, the most important auxiliaries and decomposition compounds be put up (for which purpose materials were classified into 10 groups with a maximum of each 10 sub-groups according to chemical structure), that, in addition, other physical and chemical investigation methods be used in order to increase the possibility of identification of compounds with spectra of low distinction or of mixed compounds.

The system followed consists in first plotting the spectrum of the matter in question. Observation of characteristic bands gives the key as to homogeneity and functional groups present. Comparison with reference data, either manually or mechanically, shows individual components through their characteristic key bands. Analysis of mixed compounds is feasible either through spectroscopic compensation or physical or chemical decomposition into components and evaluation of the latter's spectra. In rare cases the spectrum of pure components cannot be unmistakably identified; pyrolysis, saponification, oxidative decomposition or other methods systematically decompose substances. Investigation of the fractions will give the desired clarification.

INVESTIGATION OF MACRO-MOLECULAR SUBSTANCES BY OSMOTIC MEASUREMENT — H. Hellfritz and H. Kraemer

Since literature on the sources of error occurring in osmotic measuring and their elimination is scattered in a multitude of magazines, this paper summarizes the points to be observed, particularly as far as the technical adequacy of osmometers and diaphragms is concerned.

PROPERTIES OF "VESTOLEN" LOW PRESSURE ZIEGLER POLYETHYLENE — G. Wick and H. Koenig

Vestolen, paraffin-like high polymer hydrocarbon, producible with a medium molecular weight up to 1 million, with 85% in crystalline structure, narrow melting zone between 257 and 275°F. and processing temperatures between 374 and 428°F., is comparable to other low pressure polyethylenes on the market. Aging phenomena are discussed. Tests proved the favorable, aging-inhibiting effect of soot. Dyes compatible with Vestolen which do not exude and have good fastness to ultraviolet light are listed. Stress cracking phenomena are discussed. Relative tests have not yet been brought to a conclusive end. Physical properties of Vestolen are greatly improved if molding temperatures are kept between 483 and 572°F. (especially for undyed or soot-stabilized Vestolen) or at the normal molding temperatures between 356 and 392°F. in case Vestolen was granulated at temperatures between 483 and 573°F. A special type of Vestolen was developed for molding temperatures of 356 to 392°F. yielding the same effects as granules made at 554°F.

Upon extrusion of tubes calibration devices should be hooked immediately to the nozzle and a pressure of 2 atm. maintained. Extrusion temperature may not exceed 392°F. in order to prevent sticking in the calibrator. A specially developed adhesive guarantees superior joining of Vestolen tubes by sleeves. In case the elasticity of the sleeve is kept lower than that of the tube, such joints easily withstand the bursting pressure in tearing tests.

CHANGES IN WEIGHT AND LENGTH OF AMINOPLASTIC TEST BARS — E. Gwinner

Over a period of two years test bars from different molding compounds were observed and the measured values evaluated. Results: heat treatment after molding does not influence the fluctuations appearing during the period of observation as much as expected. Total post-shrinkage is greater in heat-treated bars than in those untreated; soaking in water for a certain period or absorption of moisture when stored in highly humid air was compensated after a few months so that test bars then showed the same status as those without post-treatment. Pre-heating of compound prior to molding did have much influence on dimensional values as shown in a chart. Effect of fillers was investigated, too, and results are cited.

REINFORCED PLASTIC SPRINGS — F. W. Reinhart and Sanford B. Newman

Excerpt from same article as appeared in SPE Journal, August 1956.

We Need
Back Issues of the SPE Journal

—the National Office of SPE receives a steady stream of requests for back issues of the Journal, and are out of the issues for Feb. 1956, Feb. 1955 and Feb. 1954.

—if you have copies you can spare, the National Office would be grateful to receive them.

SPE, 34 E. Putnam Ave., Greenwich, Conn.

FLAMMABILITY OF FILMS — H. Mendrzyk

Based on British Standard 476, films were tested as to flammability. Since results varied considerably, a test apparatus, an improvement over that laid down in British Standard 476, part II:1955, was built which is more easily accessible to cleaning. This apparatus is described and test results are discussed.

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GREAT BRITAIN
TRANSACTIONS AND JOURNAL, PLASTICS INSTITUTE
Vol. 24, No. 56

Abstracter: Harriman H. Dash

SOME NEWER PLASTICS MATERIALS — E. M. Evans — pp 199-212.

Rubber-resin blends: High impact styrenes are obtained by incorporation of 2-15% of a synthetic elastomer (butadiene-styrene, butadiene-acrylonitrile copolymer). In general the impact strength increases and the tensile strength decreases with increasing elastomer content. It has been possible to reinforce natural rubber with polystyrene to yield compounds of good appearance and higher moduli than the natural vulcanized stock. Other elastomer resin blends reported are butadiene-acrylonitrile/phenolic, isobutylene/styrene, rubber/ethyl cellulose, rubber/epoxy, epoxy/polyamide. Graft polymers with unique hydrophylic and lyophilic properties are also referenced (e.g. the Pluronics, Wyandotte Chemical Corp.)

Reinforced plastics: Glass reinforced polyesters containing triallyl cyanurate are suitable for use 500°F. Translucent, fire retardant polyesters can be produced from glycol malcate and hexachlorocyclopentadiene. Reinforced epoxies provide good interlaminar adhesion and water resistance. Modifications of epoxies and elastomers offer promising developments. A recently announced monomer, allyl-2,3-epoxy butyrate, yields polymers having polyester - epoxy characteristics.

Inorganic resins: Advances have been made with polymers based on boron and phosphorous. These have exceptionally high heat resistance. Inorganic thermosetting molding powders have been produced from calcium silicate and phosphoric acid.

Others: Internally plasticized vinyl acetate is obtained by copolymerizing the monomer with small concentrations of higher esters of acrylic, maleic, and fatty acids. These copolymers are useful in dispersion paints to yield flexible films with excellent water resistance and durability. Inherently flexible polymers similarly useful in dispersions without external plasticizers are prepared from vinyl propionate. Irradiation has been employed to initiate low temperature polymerizations in the solid state without the presence of catalysts. Cross linking by means of irradiation has also been possible for such thermoplastics as polyethylene, polystyrene, nylon, and polyacrylates. Polymethacrylates, p.v.c. and fluorinated polymers similarly irradiated undergo degradation. Ethylene and propylene have been polymerized at low pressures by means of special catalysts (Zeigler, Phillips) to yield linear, nonbranched polymers of high tensile strength, and softening temperatures (250-260°F). These polymerization processes are being extended to butylene, styrene (By Natta, Naples, Italy) and ethylene copolymers. Tetramethylol phosphonium chloride forms ethers with cellulose and p.v.al. Fibres composed of such ether polymers have excellent water resistance. Plastomeric fluorinated acrylic-esters with good oil and abrasion resistance and high tear strength have also been produced.

ALKYD MOLDING MATERIALS — J. H. Bennitt, et. al.—pp 213-232.

Four grades of alkyd molding materials commercially available in Britain are discussed. These have superior properties to amino or phenolic thermosets. The four grades are divided into (1) electrical insulating materials with versatile molding characteristics, (2) fast curing electrical materials, (3) electrical materials with special properties (e.g. high impact, self extinguishing), (4) decorative materials. Extensive comparisons are presented of each of these grades with phenolics and aminoplastics. Application and molding techniques are also discussed. Primary limitations of these materials are higher costs and greater molding difficulty. They are thus likely to remain specialized materials. However the need for their special properties has constantly been on the increase.

PROBLEMS AFFECTING THE USE OF PLASTICS IN HIGH SPEED AIRCRAFT — M. G. Church—pp 235-247.

The shortcomings of plastic materials which have no application alternative for aircraft are discussed in detail. These applications are notably radomes and transparent enclosure, for which reinforced plastics and acrylics are respectively employed. Rain erosion of radome materials occurs at 500 miles per hour speeds and the rate of erosion appears to be proportional to the 7th power of the speed. Materials with surface voids are more seriously affected. Best results in protecting these surfaces have been obtained with neoprene-rubber coatings which have a 3 hour life at 500 mph compared to a few minutes life for the unprotected surfaces. Aerodynamic heating limits the use of transparent plastics to a stratospheric speed of approximately 2 mach (twice the speed of sound). Methychloracrylate has thus far shown the most promising results. Even glass (non-laminated) is limited to 3 mach. Laminated glass has a lower limit because of the poor heat resistance of the polyvinyl butyral interlayer. Polyesters modified with triallyl cyanurate have temperature limits up to 2.6 mach, and silicones up to 3 M. These resins have possible use in radomes but their fabrication and physical properties are somewhat less advantageous than standard polyester resins. Silicones also have potential uses in foamed cores for radomes. For applications at temperatures over 300°C (temperatures encountered in stratospheric flight speeds of over 3 M.) the inorganic polymers (phospho-nitriles, phosphorous-boron, and silicones) appear to be the only promising resins for future application. Only preliminary work has thus far been done with these polymers.

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BRITISH PLASTICS
Vol. 29, Oct., 1956

Abstracter: Evert A. Mol

ECONOMIC STABILIZATION OF VINYL CHLORIDE POLYMERS — H. Verity Smith, B. Sc.

The author discusses the properties of polyvinyl chloride stabilizers with most of the attention focused on his company's products, the ferrocleres and the stancleres. A number of valuable pieces of information for the vinyl compounder are given where the author discusses such points as the peculiar relationship between the type of polymer and most effective stabilizing system. For instance, emulsion polymers of the soda prestabilized type are readily and effectively stabilized with substances like diphenol thiourea or 2-phenyl indole which have practically no stabilizing effect at all on suspension polymers like Geon 101. The author confesses that, despite a considerable outpouring of theories on both sides of the Atlantic, there is, quote, "no substitute for experiment," unquote. Points to be watched in the choice of a stabilizer or a stabilizing system are: high against low temperature efficiency, long and short time efficiency, transparency or opacity, staining, interaction with plasticizers, pigments, and fillers, and, of course, cost, specifically the volume cost.

A particularly interesting but complicated and mostly unexplained phenomenon is that of the synergism. One of the most powerful synogetic mix-

(Please turn to Page 48)

AKING OF EXTRUSION

Edited by R. D. Sackett
Technical Service Associate
Monsanto Chemical Company
Springfield, Massachusetts

Autogenous Extrusion

A. N. Gray
Western Electric Co., Inc.

The word "autogenous" is defined in Webster's dictionary as "self-generated or produced independently of external help." What is referred to as autogenous extrusion here has been generally referred to as adiabatic extrusion. Autogenous extrusion refers to extrusion without external aid in the form of heating or cooling the extruder during operation.

Autogenous extrusion may be accomplished by first so designing the screw of an extruder that it will receive material at room temperature and, by converting mechanical energy to heat energy, heat the material to the proper viscosity for extrusion. A natural balance is established which is very stable and output remains constant. It may be more convenient to preheat the entire machine to the operating temperature. Some degree of autogenous extrusion can be accomplished with standard plastic extruders as they are installed today, but to accomplish it and enjoy all of its advantages specially designed screws are necessary. Our work to date shows that it can be accomplished with considerable advantage in quality, uniformity of products, and equipment costs.

Before going further into the implications of this system with respect to its effect on equipment, it would be in order to explain some of the reasoning on which this system is based.

In figure 1 you will recognize the form of a commercially accepted plastic extrusion screw and on a somewhat enlarged scale a representation of the cross-section of the flight of this screw at "A". The arrows pointing both to and from this cross-section of flight are meant to indicate the direction of heat flow. Where the arrow points toward the section, introduction of heat is indicated, and where the arrow points away from the section, heat removal is indicated. The wavy lines adjacent to the stationary barrel are meant to represent a different consistency of the plastic material in these regions under conditions which will be described.

Virtually any extruder that is offered on the market today has a more or less elaborate system for alternately heating and cooling the machine based on the mistaken idea that, by such devices, control is accomplished. If a machine were so designed that it did not err, then no elaborate and expensive heating and cooling system would be necessary. Simple band heaters connected with an automatic thermostat would be used for preheating and maintaining desired temperatures during shutdowns. It is generally recognized that the reason for the advancement of materials through the screw is the frictional resistance offered by the material between the stationary barrel and the rotating screw, and the forward push exerted by the advancing helix. Without this friction, the material would not move. In conventional extrusion, where heat is introduced into the machine by external heaters the temperature of a thin layer of plastics immediately adjacent to the barrel is raised. With this change in viscosity the rate of movement of material along the flight is affected with a resulting undesirable change in output. Conversely, as the temperature rises above the arbitrarily selected control level cooling is applied which once again changes the viscosity of the plastic melt. This alternating heating and cooling goes on indefinitely and the effects are invariably reflected in variations in the size of the extrudate.

Having built this deliberate error into the machine, sensing devices operating through servo mechanism are used in an effort to vary the worm speed to maintain uniform size. So we have a system built to make the product wrong and another system doing its best to upset the operation

Figure 1. The Extruder Screw

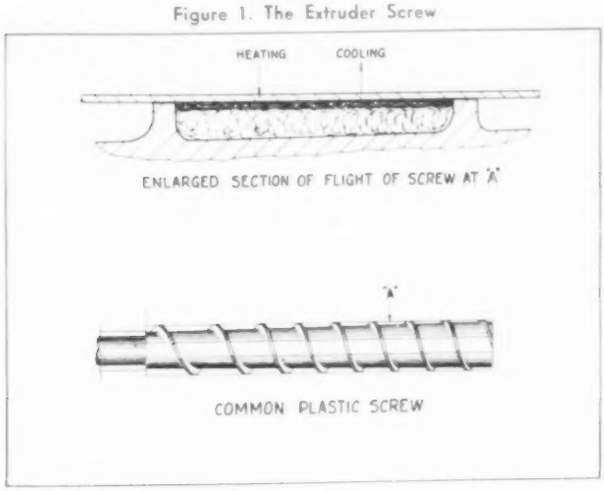
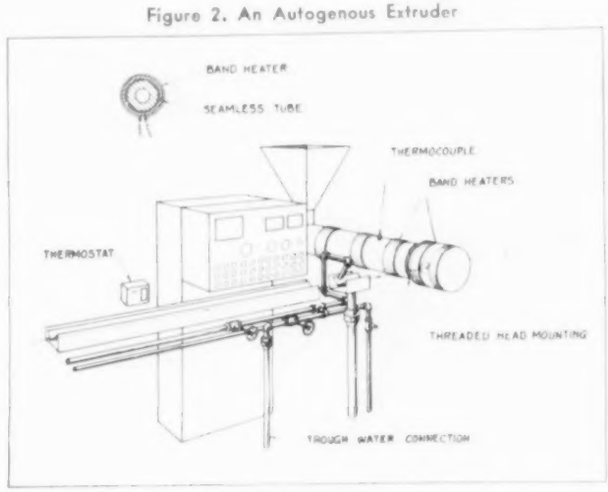


Figure 2. An Autogenous Extruder



of the machine in an attempt to correct the errors which were originally built into the machine.

To complicate present day extrusion further, there exists the possible human error by the machine operator involved in the adjustment of remaining controls. Now we should face the fact that almost universally in the plastic extrusion industry, the vital decisions affecting the dimensions of the product are left in the hands of the machine attendant. Obviously he works under certain rules and when undersize product is found, the seriousness of the error is invariably pointed out to him. Because he is checked in all cases where the product is undersize, he will always take care that he is safely above the minimum and in so doing will in many cases not concern himself with excess material used over and above that required by the specification. Because of the relatively large human factor involved in extrusion every valve, every switch, every control device of any sort which is subject to the operator's adjustment is a danger point which should be eliminated. The equipment should be engineered to eliminate as much as possible the human factor. This may seem visionary to some, but it appears quite within the realm of possibility.

These remarks have some very drastic implications with respect to the designing, construction and installation of plastic extruders. In the first place, the carry-over of design from rubber extruders is too extensive. The more or less elaborate heating and cooling systems are superfluous as are also the correctional devices used to correct these faulty conditions.

Figure 2 is a sketch of a proposed autogenous extruder showing the great reduction in auxiliary equipment over a conventional extruder. Although it would be difficult to evaluate the difference in cost between an ordinary extruder and an autogenous extruder it appears obvious that an autogenous extruder would be much less costly to build and to install. It would also be much more satisfactory in operation.

If this proposal raises skepticism, it is not surprising. However, autogenous extrusion is being done experimentally by the Western Electric Company. There remains considerable work to be done, first to develop the know-how and, second, to refine the screw and tool design.

An obvious question is "How do you compensate for variation in material flow properties in a constant speed machine such as the one you propose?" A variable speed machine must have variable torque in order to maintain a constant speed under varying load conditions. Where colder or stiffer flowing material is to be extruded the system would be upset unless some correctional device is provided. A correctional device is built-in. If the screw persists in rotating at the same speed, it must do more work on the colder material, and it will do more work exactly to the amount required to bring this colder plastic to the exact condition that all the preceding material has been brought. Conversely, should the material be warmer and, therefore softer, the screw continues to turn at the same rate but does less work to bring the material into the same condition for extrusion. Heat loss, through radiation from the extruder is something which might also be reckoned with. In most factories, the temperature in the neighborhood of the extruders varies from 80°F to 100°F. It is doubtful that the temperature variation of 10°F can upset the operation of these machines which are operating at 350°-400°F. Because, as in the case of deliberately adding cold material, it matters little whether the machine works a little harder or little less as it processes the material. So long as the rate of the screw remains constant, the necessary amount of work, and only the necessary amount of work, will be done.

Autogenous extrusion leaves many questions to be answered for sure. But this is true—it has been done with some thermoplastics and gives every indication that it will be applicable to all thermoplastics.

AROUND THE WORLD

(Cont'd from page 46)

tures yet developed is organotin-barium-cadmium-epoxide, developed to provide an economic method of producing highly plasticized compounds. The author includes a short descriptive list of the available types of stabilizers and mentions as a field for new developments the production of non-toxic stabilizers.

PRODUCTION OF SHEET FROM TOUGHENED POLYSTYRENE—D. G. Peacock, D.I.C., B.Sc., A.C.G.I.

The article describes in some detail the production of toughened polystyrene sheet in thicknesses from .010" to .180". Toughened polystyrene sheet can not be made with the same smooth surface of general purpose polystyrene, but an agreeable surface finish can be imparted by polishing or laminating. The data given in this article all refer to Bextrene BC-15 made by BX Plastics. Considerable attention is paid to the extruder design, in particular to screw profile, back pressure and mixing provisions, barrel heating, feed system, and die construction. The die is of the center-fed manifold type and features an internal adjustable restrictor. On a .040" sheet a tolerance of 1 mil is possible; with .180" sheet about 5 mils are reasonable. The remainder of the article is devoted to the finishing and handling operations. The haul-off unit, foil laminating and polishing operations, panel cutting and batching are briefly discussed.

ALKYD MOLDING MATERIALS

Alkyd molding materials are based on resins of the diallyl phthalate type which can be modified with linear unsaturated polyesters. Unlike phenolics and amino plastics, they cure by addition polymerization so that no volatiles are produced in the molding operation. This feature gives them their special properties in respect to low molding pressures, high rate of cure and stability. The article goes on to describe the new common molding conditions and a number of typical applications both technical and decorative.

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HOLLAND
PLASTICA

Vol. 9, No. 10

Abstracter: W. P. ter Horst

RECENT DEVELOPMENTS IN THE FIELD OF EPOXY RESINS — J. H. van der Neut — Page 615-619

A survey is given about the present state of the conceptions concerning the curing of the classical epoxy-resins with different curing agents: carbonic acid anhydrides, unmodified and modified amines and polyamides. The advantages and disadvantages of these hardeners are mentioned.

Some applications and potential applications are described.

Abstracters are needed for both American and foreign journals. No pay but the satisfaction of doing your fellow members a service. Write to Editor, SPE Journal, Security Bank Bldg., Athens, Ohio.

SECTION NEWS

Edited by
Charles P. O'Donnell
Monsanto Chemical Co.
Springfield, Massachusetts

Upper Midwest

Quality Control in Plastic Molding

F. W. Brown

Paul Becker, Upper Midwest Section vice-president conducted the November 19 meeting. Mr. Becker referred to the work of the National Professional Activities Group and asked that members interested in seeing one of the professional committees formed sign the necessary petitions. Mrs. Luther Bolstad reported on the isocyanate symposium sponsored on October 23 in Minneapolis by the Upper Midwest Section. The Symposium was very successful with 160 persons attending from sections all over the country.

Speaker of the evening was Mr. Donald Baron, Director of Quality Control at Minneapolis-Honeywell Regulator Company. This was Mr. Baron's second appearance before this section having appeared here five years ago. The subject of his address was "Quality Control as Applied to Plastic Molding." He stated that no basic changes have occurred in quality control in the last five years, but he indicated a need for better communication between quality control personnel and people in production, research, and management. He then directed his talk toward defining what quality control is and toward explaining the various terms used in quality control. Quality control can be divided into two areas—an area of indirect control and an area of direct control. The area of indirect control is concerned with the quality built into the product by the designer and embraces the specifications set by the designer. The area of direct control involves the conformity of the product to the design specifications and is the area of direct concern to quality control men.

Five types of activity are involved in a quality control program. These are (1) acceptance sampling (2) process control (3) new developments (4) analysis of production problems and (5) records and reports.

Of these, acceptance sampling is the area of greatest initial saving. A complete quality control program requires that there be a receiving inspection, process control at those points where it is economical, and a final inspection.

In addition to measuring quality, a quality control program must also take corrective action. Because technical progress has demanded tighter and tighter specifications, quality must be built into a product and not sorted out. Quality control is a staff activity that can provide production people with the facts needed to accomplish this.

Mr. Baron then discussed the concept of A.Q.L. or acceptable quality level and developed the Operational Characteristic Curve from the addition and multiplication theorem in terms of the lot size, sample size, and acceptance number. He defined acceptable quality as that quality which we want to accept 90-95% of the time. Mr. Baron concluded his remarks by illustrating the effect of an acceptance sampling program on various departments in a manufacturing plant. Mr. Baron accomplished the purpose of his talk in that he gave the layman a better understanding of quality control and its purposes.

Eastern New England

Silicones in Industry

Alfred I. Simon

A joint meeting of the Eastern New England Section of the S.P.E. and the Boston-Providence chapter of S.P.I. was held at the Hampton Court Hotel in Brookline, Massachusetts on October 30, 1956. Approximately 100 members and guests were in attendance.

Local S.P.E. President, Ralph Mondano, opened the meeting by distributing a letter from Mr. Lewis Gustafson, local S.P.E. President of the Western New England Section, inviting members of the Eastern New England Section to visit jointly Monsanto Chemical Company on the afternoon of November 7, 1956. Invitation to the Western New England monthly meeting that evening was also extended. Copies of this letter were distributed to the audience to obtain a list of interested members. Mr. Mondano then mentioned that a bid would be made to hold the 1962 National S.P.E. Technical Conference in Boston. It was announced that the second annual $200 scholarship sponsored by the Eastern New England Section of S.P.E. would soon be awarded to a worthy sophomore student in the Plastic Engineering course at Lowell Technological Institute. It was also announced that the all-New England Regional one-day Technical Conference on "Plastics for Electronics" would be held the second week of June, 1957 in place of the January 3rd date previously selected.

Program Chairman, Gim Fong, presented as the first speaker of the evening, Mr. Melvin E. Nelson of the Dow Corning Company. His subject was "Silicones in American Industry." Some of the highlights of his talk included the fact that a motor wound with silicone resin insulation has withstood constant copper temperature of 240°C for 66,000 hours. Another motor wound with silicone resin insulation ran for 200 hours at 400°C before breaking down. These types of wound motors weigh very much less than Class "A" motors of the same horsepower rating.

Silastic rubbers have been compounded which have withstood temperatures as low as minus 180°F. Low swell fluoro-silicone rubber LS53 has been used for sealing against hydraulic fluids. Mr. Nelson then discussed silicone foam which requires 350°F for processing in the 10 to 18 pounds per cubic foot density range. This material has been used as a core for airplane propellers and radomes. A room temperature foaming material investigation is currently in process.

Glass fiber reinforced silicone compound 301 is similar to glass filled alkyds, but has a temperature resistance up to 800°F. The bulk factor is about 7 to 1; molding temperature, 350°F; cycle 5 to 10 minutes. An after-bake of 250°C is recommended. Units molded from this material have withstood as high as 2,000°F for very short term operation. The speaker then went on to discuss silicone laminating resins. He also mentioned the development of a castable silicone resin called R7501. This material is catalyzed by a peroxide and cured at 125°C to 150°C.

(Turn page)

New England—(from page 49)

The next speaker was Mr. Harvey L. Parry of Shell Chemical Company. His subject was "Epoxy Resins in Non-Surface Coating Applications." He discussed the chemical aspects of epoxy resins manufacture, including various curing reactions and resulting products. He listed various types of curing agents with their operating temperature characteristics. Operating temperatures as high as 200 C for epoxies are a reality, utilizing such curing agents as PMDA and chlorendic anhydride as well as newly developed epoxy resins. Operating temperatures in the 250 C range are a realistic possibility in the very near future.

Mr. Parry then went on to discuss formulation variables and their effects. He showed where it was more desirable to utilize reactive diluents instead of solvents as viscosity modifiers, when mechanical properties are to be maintained. Plasticizers or flexiblizers increase the toughness, but lower the ultimate tensile strength. The effects of fillers on mechanical properties of epoxy resins show that they can decrease the coefficient of thermal expansion, reduce the exothermic temperature, lower the shrinkage, improve the thermal conductivity and lower the cost. Where asbestos will act as an inhibitor with boron trifluoride epoxy catalyst, copper powder will act as an accelerator with aromatic amine epoxy hardeners.

Mr. Parry then discussed wet layup laminating, filament winding, dry layup laminating, casting, putty and trowel coating techniques and adhesives. Among the applications cited were reinforced pipe, printed circuits, plastic tooling, automobile body solders, embedments and structural adhesives. The bonding of stainless steel to stainless steel has given tensile shear strengths of 1,000 psi after 200 hours at 500°F.

Both talks were supplemented by very interesting slides which included a number of technical graphs. A question and answer period followed each talk.

Toledo

Plant Tour Made

F. B. Rosenberger

On Wednesday night November 14, the Toledo Section enjoyed one of their most interesting plant trips of recent years with their visit to Champion Molded Plastics, Bryan, Ohio.

Prior to the plant tour, the group assembled for dinner at the Elder Hotel. At the conclusion of the dinner, Mr. Frank Schneider, plant manager of Champion Molded Plastics and host to the group, introduced other members of his staff and gave a brief resume of the rapid growth which Champion has enjoyed.

Mr. Schneider also gave a brief summary of some of the typical problems encountered by his company in his discussion of injection press operation, molding material performance and finishing operations.

The plant tour itself was most interesting with all departments in operation, including finishing. Special personnel of Champion were available throughout the plant to answer questions of the group.

Detroit

Potentialities of A New Ethylene Polymer

Malcolm A. Nichols

After a series of extremely successful Spring and Fall Golf Parties, the Detroit Section donned their garb of serious mien and opened their 1956-57 Technical sessions at the Dearborn Inn on November 12th.

Approximately one hundred members and guests heard Wm. O. "Bill" Bracken, Manager of Hi-fax Sales for the Hercules Powder Company, discuss and exemplify the characteristics and potentialities of a new ethylene polymer, commercially known as Hi-fax, that has been developed by his company.

Mr. Bracken fully discussed the origin and chemistry of the new marketable polymer stating that the new linear polyethylene was developed in Germany in 1951 and adhered to the Zeigler type of chemistry. He declared that Hi-fax retains all of the properties of conventional polyethylene and offered greater rigidity, better strength, heat resistance and appearance.

The new material is resistant to mineral and vegetable oils, salt brine and has been approved for use in numerous household items, particularly those utilizing foods and liquids. It can be molded by injection, compression or extrusion techniques, and sheets may be drawn or vacuum formed.

Mr. Bracken, by means of slides, showed charts depicting the comparison between his product and the commonly used commercial polyethylene.

Samples of production items that had been successfully molded in Hi-fax were shown and discussed among which were toys, industrial moldings, pipe, electrical insulation, housewares, sheet and film, bottles and battery parts.

Pioneer Valley

Plastics in Electronics

John T. Moore

The meeting was held at Wachusett Country Club, West Bolyston, Massachusetts on October 4th. There were approximately 65 members and guests present. After a roast beef dinner, the President, Mr. Fred Schreiter, opened the meeting. Mr. Jack Berger, Program Committee, announced that the November meeting would be held on the 15th at Wachusett Country Club, and would be a ladies' night dinner dance. Cost will be $5.00 per person.

Mr. Schreiter introduced the five newest members-in-process, Messrs. Johnson, Scott, David, Pethybridge, and Demus. He also introduced visiting guests, Chet Ackerson of Foster-Grant Company and Ken Boyer of Modern Plastics Machinery.

Mr. Berger introduced the speaker for the evening, Mr. Ralph L. Mondano, whose subject was "Some Interesting Aspects Of Plastics In The Electronics Industry."

Mr. Mondano received his formal training at Yale University and M. I. T. Before joining Raytheon Mfg. Company, he headed the Consolidated Boiler Research Laboratory; one of the main functions of which was the study of the heat requirements for the industrial processing of plastics. He is at present Department Manager of Plastics Operations in the Research Division at Raytheon Mfg. Company. He is a member of ASME., A.S.T.E. and A.C.S. He is currently president of the Eastern New England Section of S.P.E. He is a registered professional engineer, State of Massachusetts, and has written and published several articles for electronics and plastic tooling.

Mr. Mondano's talk concerned some of the difficult problems solved in manufacturing radomes and radar reflectors. Epoxy resins in conjunction with glass fabrics and honeycomb structures or foamed alkyd interlayers are used in the construction.

Mr. Mondano explained and illustrated the extreme dimensional tolerances required in these electronic components. He stressed the flexibility in properties attainable through the use of epoxy-polyamids and epoxy-polysulfides. Numerous samples were exhibited of the work done at Raytheon. It was reported that the work had progressed to a point so that about 100,000 pounds of epoxy materials were used by Raytheon in the past year. A demonstration of the production of a foamed isocyanate stimulated many interesting questions. The question period following showed the keen interest of the audience in these developments.

Joint Group Examines Monsanto House of the Future

C. P. O'Donnell

A joint Eastern and Western New England Section visit to the Plastics Division headquarters plant of Monsanto Chemical Company, followed by the monthly dinner meeting at Bradley Field with Eastern members in attendance, highlighted the Western New England Section's gathering for November 7, 1956.

The group visiting Monsanto, hosted by Mr. Wm. Wiese and Mr. M. X. Gigliotti, attended an illustrated talk by the Monsanto Structural Plastics Engineering Group on "Plastics as a Construction Material," visited the test site for prototype house components of the Monsanto House of the Future, and participated in a general question and answer session under the guidance of Mr. Gigliotti.

The Bradley Field meeting of the hosting Western New England Section saw more than 115 persons attending, approximately 30 coming from the Eastern Section's membership. The educational topic for the evening, "Trends in Designing Equipment for Vacuum-Forming and Extrusion," was handled by Mr. Myles Kalahar of Kal Plastics and Mr. Gaylord Brown of Brown Machine Company under the Technical Chairmanship of Armand Vallieres of Prolon Plastics.

A film was featured during the Monsanto visit. Taken during the construction of the Monsanto Plastics' research building, the film graphically demonstrated plastics applications in the building trades as used in the very building where the meeting was taking place. Mr. R. P. Whittier gave the accompanying talk.

The group then adjourned to a nearby test site where a full scale section of the Monsanto House of the Future was being exhaustively tested. Mr. K. D. Hatch explained the various tests and loads and answered questions from the group. He explained that the tests were being held prior to beginning construction on the full-size prototype on site in Disneyland. These tests were not only pertinent for furthering construction knowledge of the House itself but a safety measure needed before subjecting the completed house to the extraordinary stresses and strains it would receive when open to the public in Disneyland. It was pointed out that the load the cantilevered, reinforced polyester resin wing was then supporting was equivalent to "a wedding party of 75 persons — with grand piano—gathered in the one wing during a 50 mile-an-hour hurricane, while an earthquake took place at the same time."

The visitors then returned to the research building for an open question-and-answer period. Light refreshments were served before the entire group moved to the Bradley Field meeting by car-caravan.

The Western New England Section President, Mr. Lew Gustafson (Prophy-lac-tic Brush Co.), introduced Mr. Ralph Mondano, President of the visiting Eastern New England Section. Mr. Mondano said a few words of appreciation and gave a brief synopsis of their Sectional activities at the moment. He touched on the latest Eastern New England Section scholarship award to Lowell Technological Institute and suggested a similar, combined Eastern and Western New England activity for the future.

Mr. James R. Davidson, Executive Secretary for National S.P.E. Offices, was then introduced to the members. Mr. Davidson expressed his enthusiastic approval of the day's activities and commended the Sections for the vigor they had shown in their overall activities and membership attendance.

The Executive Secretary went on to say that the intention of unifying the S.P.E., to the point where concerted efforts to upgrade plastics could be applied, was gaining impetus. The goal, making plastics the number one industry in the United States by dint of this upgrading, looked more and more promising thanks to membership enthusiasm and the developing singleness of purpose, according to the speaker.

In closing, the National Officer said that the 13th Annual S.P.E. Technical Conference in St. Louis, January 16, 17, 18, 1957, should provide excellent educational material for S.P.E. members. With three large meeting rooms containing excellent P.A. Systems, and with ample personal hotel accommodations, the likelihood of member inconvenience is small. An added attraction at the Conference will be the presentation of the 1st S.P.E. volume, "Quality Control for Plastics Engineers."

The educational session as presented by Mr. Kalahar was based on his extensive experience in extrusion and vacuum-forming work with Dow Chemicals and Kal Plastics. The speaker pointed out that his present position as Kal Plastics' President was a direct result of his interest in development work on a continuous vacuum-forming process co-ordinated with a sheet extruder.

Originally Mr. Kalahar had worked with a 4½" extruder having a 20:1 length over diameter using 50 Hp. U.S. drive. This consumed great quantities of raw materials in the making of plastic sheets and led to his designing his own extruder screw. With a constant root, diminishing pitch, 2 to 1 compression ratio, and 6½" diameter mixing torpedo he claimed constantly uniform delivery, excellent plasticizing and color dispersing qualities, and an output of 450 lbs. per hour at 45 RPM screw-speed.

The Kal Plastics speaker listed many additional developments he had worked on, including a manifold-type sheeting die, jet-type loader, and many refinements of the various components in this type of extruding and vacuum-forming operation.

The speaker then continued his discussion with a slide presentation on various types of sheet extruders and continuous vacuum-forming machines he was concerned with. This included continuous drape and continuous plug assist, rotary, and other units. Mr. Kalahar went into great detail on the operation of each unit, modifications made to improve performance or permit special operations, and the major advantages and drawbacks in each type of machine.

Trimming operations were also discussed, as well as some of the ultimate aims behind many of the refinements developed. Some aims which indicate successful achievement are: controlled sheet tolerance of ± .01" through use of a double-nip close to die lip (which also allows closer regulation of the number of sheets to a pack); thinner over-lay laminating film to give satisfactory gloss (a refrigerator liner as a sample result was passed among those present); heated conveyor rolls from extruder to polisher to give any surface finish; and many more.

In his extensive coverage Myles Kalahar used many actual production line samples which aroused considerable interest. It was pointed out that the sample from one particular 9-cavity continuous forming unit permitted a competitive pricing of about 1½c due to savings through the correlation of extruder and vacuum-forming operations.

Newark

Advertising Puts Money in Your Pocket

R. Bostwick

Approximately 100 members and guests attended the regular meeting of the Newark Section on November 14. The program for the evening featured two speakers. Mr. Richard Hardesty, of duPont, spoke on "Alathon Polyethylene Resin — Effects of Molecular Structure on Properties." Mr. M. H. Straight of Spencer Chemical Co. spoke on "Advertising Puts Money in Your Pocket."

Mr. Hardesty, the first speaker, presented a duPont paper on the relationships between the molecular structure of branched-chain polyethylenes and important end-use properties. Some fundamental factors are: weight-average molecular weight, number-average molecular weight, number of short-chain branches per 100 carbon atoms, and the long-chain branching index. Two composite characteristics of polyethylene based on these factors are melt index and density. The speaker explained the calculation and significance of the two molecular weight averages, and showed how the ratio of the two was a measure of the molecular weight distribution. The short-chain branching index is the number of chain ends per 100 carbon atoms, while the long-chain branching index is the number of long branches per 100 carbon atoms. Melt index is an arbitrary measure of the fluidity of the molten polymer under certain specified conditions. It is a function of both the weight-average molecular weight and the chain branching. Density is a measure of the crystallinity of a sample of polyethylene and is a decreasing function of the short-chain branching index.

The speaker then listed a number of properties of polyethylene of end-use importance and showed how they are related to these molecular characteristics.

1. Stiffness and yield strength—These are both direct linear functions of crystallinity, or density, and are not related to melt index or molecular weight distribution.

2. Tensile strength—This is related inversely to melt index, and also is higher for narrower molecular weight distribution. It is not appreciably affected by density.

3. Tear strength—The Graves tear strength is dependent mainly on the density. The Elmendorf tear strength is related to molecular structure in a way not yet completely understood.

4. Permeability—This is related inversely to crystallinity.

5. "Processibility"—Melt index is a convenient measure but can not be expected to cover all circumstances.

6. Film Brittleness—This property increases with increasing density and melt index. A narrow molecular weight distribution offers practical advantages here.

7. Low Temperature Brittleness — The utmost in low temperature toughness would be found in a very dense resin of extremely low melt index, and the narrowest molecular weight distribution possible.

8. Stress-Cracking—This is very dependent on melt index and molecular weight distribution. Resistance to stress-cracking increases with decreasing melt index and narrowing distribution.

The second speaker, Mr. Straight, presented a dynamic portrayal of the importance of advertising. He pointed out that in this country 9 billion dollars was spent for advertising in 1955. This was three times the amount spent in 1946. This is naturally reflected in the sales price. For example, when we buy a pack of cigarettes we spend 2.5 of a cent for the advertising. Buy a can of soup at the local supermarket and you have spent almost a penny for the advertising.

Mr. Straight referred to advertising as "salesmanship with automation." For example, a black and white page in Life magazine costs $21,775, but it carries a message to 5,600,000 prospective customers. In other words, it makes a sales call for less than 2.5 of a cent. A full color, double page spread costs only 1 1.3 cents per subscriber.

In the plastics field, Mr. Straight felt advertising had a job of education to do. For example, to make the public understand that there are many different plastics. Also, increasing production of such plastics as polyethylene makes it essential that we expand their uses.

Mr. Straight showed and discussed some ads that he considered highly effective. In conclusion, the speaker left the thought that advertising is pressure — a constant, unrelenting pressure which propels goods through the pipelines of American industry.

Peerless Molded Plastics

John M. Van Loon, Jr., has been appointed representative for the entire state of Michigan for Peerless Molded Plastics of Toledo, according to an announcement by William G. Skutch, Sr., President of the Toledo company which produces custom molded plastic parts, by the injection, compression or transfer method, for the automotive, refrigeration, electrical and other industries.

Van Loon has opened offices at 16225 E. Warren, Detroit.

New York

Asbestos Reinforcements

James Dugan

The Reinforced Plastics Group of SPE's New York Section held its first meeting of the fall season on September 26, at Tufaro's Restaurant, Corona, L. I., N. Y. Over 50 members and guests were in attendance.

D. V. Rosato, Raybestos-Manhattan, Inc., spoke on "Asbestos Reinforcements for Plastics," pointing out the outstanding characteristics of his firm's Pyrotex felts and mats and Novasbestos papers and cushioned glass-warp. The felts wet readily, retaining their strength properties. This feature permits their use in continuous laminating processes, prepregs, and dry layups. When used without a binder, they require carriers through the resin bath and drying tower. The mats are pre-impregnated with phenolic resins, and can be cut to pattern. A three-month shelf life can be obtained with proper refrigeration.

Novasbestos papers offer particularly smooth surfaces in laminations, plus a high degree of compatibility. They are made by separating asbestos into single-component fibers which are held in dispersed condition. Cushioned glass-warps are made by impregnation with polyester or epoxy resins.

"Stanpreg — The All-Purpose Polyester Pre-Impregnated Glass Cloth" was discussed by Alex Sacher, Standard Insulation Co. The cloth obtains its flame resistance from a special resin formulation, rather than by the use of fillers which often reduce strength, flexibility, and flow. Stanpreg is reportedly self-adherent, but will not stick to the operator's fingers. Productivity and drapability is thus enhanced. A shelf life of over six months can be expected.

"Mold Heating and Temperature Control" was the theme of October 31 meeting, Reinforced Plastics Group, SPE's New York Section. Tufaro's Restaurant, Corona, L. I., N. Y., was the locale.

William Hemmel, R. L. Faber & Associates, spoke on "Mold Heating and Temperature Control," pointing out that precise temperature control is essential to quality moldings. Temperatures of 90-1,200°F., can be maintained with properly installed, metal-sheathed resistance heaters, according to Mr. Hemmel, who described three essential types.

Strip heaters are used with large, flat platens having milled grooves in their rear faces. Resistance wires can be stretched to offer lower wattage in the center, higher at the strip ends. Tubular heaters have coiled resistance wires surrounded by refractory material in a seamless metal tube.

Sheath materials can be aluminum, copper, steel, or inconel; but must be used in compatible environments. Cartridge heaters are simply installed in a close fitting, drilled or tapped hole. Further discussion was devoted to heater selection, especially with respect to the heating of cast resin dies.

"Liquid Heating" was covered by Bernard S. Breitman, American Hydrotherm Corp., LIC, N. Y., including water, heat-transfer oils, diphenyl chlorides, aryl silicates, diphenyl-oxide mixtures, tetra cresyl silicates, and eutectic salts. Advantages of liquid heating were reported as follows: maintenance of uniform temperatures; use of the same fluid throughout a range of heating cycles; accurate temperature control; immediate response; separate control over separate temperature zones; and control over the heating and cooling circuits. Many times calender speeds have been increased from 25 to 250 yards per minute through change to liquid heat, according to Mr. Breitman.

Kansas City

Designing With Plastics

Philip G. Fleming

The meeting was held in the Napoleon Room at Milleman's Restaurant, on the Plaza, in Kansas City, Missouri on November 6, 1956 (Tuesday). Mrs. George Roach, Vice President, presided in the absence of the President.

Mr. F. L. Brevoort, Supervisor of Application Design Group of the Chestnut Run Laboratory, the du'Pont Company, Wilmington, Delaware, was the main speaker on the subject, "Designing With Plastics." Mr. Brevoort was introduced by Mr. Robert Thomson.

Mr. Brevoort gave a most interesting and effective lecture covering designing with plastics. The discussion took in:

1. Estimating
2. Materials Selection Design
   a. Property testing
   b. Asthetic properties
   c. Cost factors
3. Fabrication Design
   a. End use
   b. Weight
   c. Ease and integrity of assembly

It was stressed that designing with plastic materials require the same basic principles as are used for metals. Slides depicting graphs of properties were used to emphasize this point.

Case histories of specific items (mostly nylon) were used to illustrate the discussion. Sample parts were displayed showing fastening of thermoplastic parts by explosive rivets, resistance welding and friction, or spin, welding techniques.

Rhode Island

Preheaters & Hydraulics

Glenn A. Tanner

The November meeting of the Rhode Island and Southeast Massachusetts Section was held in the main dining room of Wayland Manor, Providence, R. I. on November 29, 1956. The fine turnout was credited to excellent speakers, Mr. Robert E. Carr, Development Engineer of General Electric Co., Taunton, and Mr. Jack Carpenter, New England District Manager of Vickers, Inc.

The speakers for the evening were introduced by Mr. Sydney Lohman of Lester-Phoenix, Inc., Program Chairman.

The first speaker of the evening was Mr. Robert E. Carr, Development Engineer in charge of the advanced engineering unit at Plastics Department, General Electric Co., Taunton, Mass. He revealed for the first time some recent work they had done on the dielectric heating of phenolic molding compounds. The results of this research showed the members how to get the most out of their electronic preheaters and, at the same time, exploded many of the older theories or myths on preheating.

For example, it has been accepted for some time, by most molders and technicians, that the electronic preheating developed the heat within the preform from the center outward. Mr. Carr showed, by means of very accurate temperature readings at various points throughout the preform, that in actual practice the center of the preform is colder than the peripheral edges. In fact the uniform temperature lines form approximate concentric circles from the center of the mass. On rectangular preforms, lying flat, the same point is apparent with the corners the hottest spot.

If this same rectangular preform was set on edge, the temperature difference within the preform dropped from close to 100 degrees to a variation of 60 degrees. In either position, if this preform is centered between the plates, the temperature difference within the preform drops to 25 to 35 degrees. This makes it very comparable with the 25 degree temperature difference encountered throughout the mass of a round preform.

By the incorporation of a polyester lens, the temperature difference throughout the preform of either shape can be cut to about 3 degrees.

Mr. Carr presented a number of graph charts, which further showed how the heating rate varied with the electrode spacing and the electrode area. He also showed how plate current can be used to control the rate of heating, and how increasing the air gap can affect the heating rate, due to the capacitance of the air gap.

Although it has been somewhat commonly accepted for some time, that the higher the density of the preform—the better the heating, Mr. Carr also showed where this likewise is a fallacy. His test proved that, when we increased the density of the preform, we actually decreased the heating rate. Because of this variation in the heating rate, however, it still is important to strive to obtain a uniform density throughout the preform.

In summarizing, Mr. Robert Carr stated that he could find no evidence that dielectric preheaters heated phenolic materials uniformly, or from the inside out. Neither could he find it an advantage in making extremely hard preforms for preheating purposes. He did find, however, that you should use a minimum air gap and a plate as near as possible the size of the preform.

The second speaker, Mr. Jack Carpenter of Vickers, Inc. showed the transition in hydraulic circuits in injection molding machines since the first units were produced. Hydraulics, he stated, have been a definite part in the advance in this modern technological era and plastics have been a great part of this advance. The problems which are presented to today's hydraulic engineer are those of motion, thrust, and interlock.

Although the first hydraulic systems on injection machines were simple, the modern circuits are much more complex for reasons of speed, automation, new techniques and new materials.

The steps of these advances are as follows: 1. Manual, 2. Automatic with interlock control, 3. Safety devices and safety measures, such as the gate actions, 4. More speed, accomplished by going from 1000 to 2000 and 3000 psi 5. Incorporation of deceleration at both close and open points, 6. Starting the plunger forward before the stroke, and 7. Incorporation of devices such as booster, stuffing mechanisms, core pulling mechanisms, and plasticizing equipment.

Because of the modern complexity of the equipment, maintenance becomes of ever-increasing importance. This maintenance can be divided into three sections—1. Care of the pump and controls, 2. Care of the piping, (particularly stopping leaks), 3. Care of the oil (viscosity temperature and cleanliness).

Both speakers were presented with many questions, which they answered quite authoritatively.

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Meeting Notices

"Plastics for Electronics" is the theme of the Regional Technical Conference to be presented on June 14, 1957 at M.I.T., in Cambridge, Massachusetts. Further information may be had by writing to the general chairman Ralph Mondano, Raytheon Mfg. Co., Foundry Ave., Waltham, Mass.

"The Engineering Aspects of Polymer Processing" symposium will be held by the American Chemical Society on April 7-12, 1957 in Miami, Florida. Those interested in presenting papers should write to Dr. James Church, Dept. of Chemical Engineering, Columbia University, New York 27, New York.

Peacetime uses of atomic energy will be the topic of the 1957 **Nuclear Congress,** scheduled for March 11-15 at Philadelphia's Convention Hall, under the coordination of Engineers Joint Council. The session will bring together leaders in science, engineering, industry, government, education, agriculture and other fields. For information write to Engineers Joint Council, 29 West 39th St., New York 18, New York.

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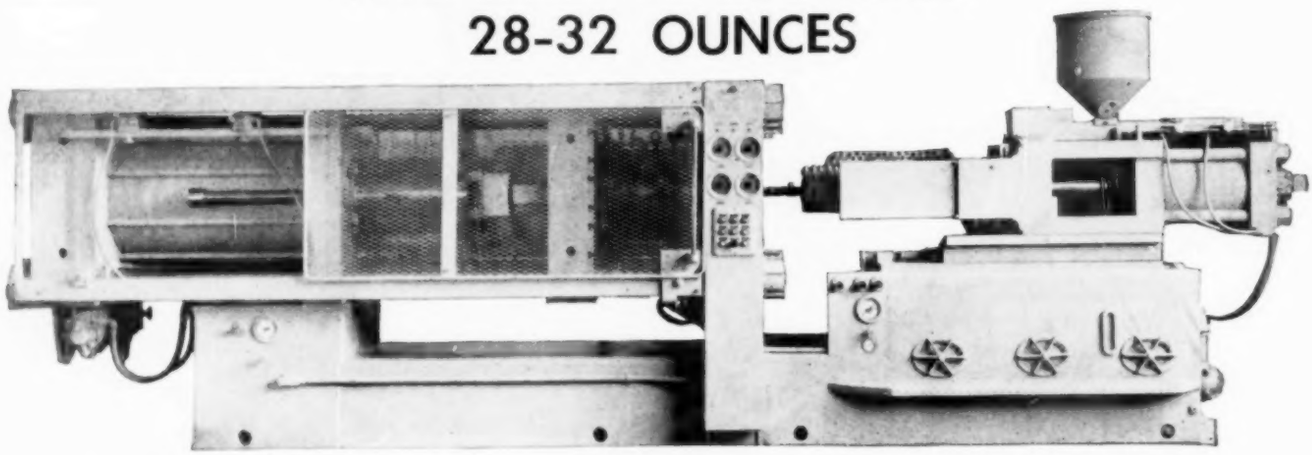

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Basic Characteristics Of Polyethylene Resins

John A. Stahmann

Mr. John Shelton of Du Pont presented a talk on the fundamental characteristics of polyethylene resins and their relationships to the properties of the final product.

While polyethylene resins have many basic properties in common, there are also differences which depend upon the molecular configurations and the distribution of molecular weights. The relation between structure and properties is becoming definite enough to aid in the design of a resin to meet specified requirements.

Fundamental molecular characteristics that may be used to describe the various polyethylenes include the weight-average molecular weight, the number-average molecular weight, the molecular weight distribution, the percentage of short-chain branches, and the long-chain branching index. The melt index and the density are composite characteristics, which are arbitrary measures of the fluidity and crystallinity of the polymer. After defining these terms, the general effects of molecular weight distribution, melt index, and density were described.

The molecular weight distribution is indicated by the ratio of the weight-average molecular weight to the number-average molecular weight. A narrow range of molecular weights in a polyethylene gives increased tensile strength, increased resistance to environmental stress-cracking and an increased softening temperature. Brittleness and ease of processing decreases.

If the density and molecular weight distribution are held constant, then an increase in the melt index increases the fluidity, drawability, and coefficient of friction. At the same time there is a decrease in the tensile strength, tear strength, and resistance to environmental stress cracking.

The density or crystallinity, when increased, will increase the stiffness, yield strength, tear strength, softening temperature, impermeability, and brittleness. At the same time the creep and flex life will decrease.

Charts illustrating these points were shown. It was pointed out that an improvement in one property may involve the loss of another desired characteristic; therefore, compromises in final properties may have to be made.

Central Indiana

Panel Offers Discussion On Epoxy Resins

C. R. Smith

Central Indiana Section's meeting at the Warren Hotel in Indianapolis on November 27th proved one of the best presented, best attended and best received programs of the current year.

A group of 82 guests and members turned out to hear a panel discussion on epoxy resins by Mr. Hartley K. Phinney, Bakelite Co., Mr. Howard Henderson, Ren Plastics, Inc. and Mr. Irving Poston, Allison Div. of G.M.C.

Mr. Phinney presented the resin manufacturer's views and explored the many applications for this versatile resin. He pointed out its many capabilities and just as candidly its limitations, as well as a progress report on development efforts for improvement.

Mr. Henderson presented the plastic toolmakers' views and gave pictorial evidence of its wide acceptance in both the automotive and aircraft industries. Some of the jigs and gauges illustrated were large enough to check entire automobile and truck body assemblies and even entire sections of an aircraft fuselage. Percentage comparisons were made of time, material and labor involved in the manufacture of a plastic tool against more conventional methods, pointing up the reductions in cost and completion time that might be anticipated in a proper application. Mr. Henderson also admonished his listeners to consider their particular problems carefully before deciding on the plastic tool approach, pointing out that in some instances there are no advantages and each case must rest on its own merits.

Mr. Poston presented the end user's views and gave a very complete run down of his company's brief but intensive investigation of epoxy applications. Proof of its acceptance is illustrated by his department's growth from one part-time employee to thirteen employees in little more than a year. He illustrated the ease with which they are able to handle the many engineering changes associated with a part from development to production. In one instance they completed the entire cycle of discussion, tool change and sampling of a stamping die in one day. He also related their experience with epoxy resins in other miscellaneous applications such as casting a new surface plate from a granite original, repairing the worn ways of a milling machine and others further illustrating the remarkable properties of this versatile resin.

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"Leaders in phenolic plastics"

book reviews

Cosmetics. Their Principles and Practices

By Ralph G. Harry, F.R.I.C. 786 pp. $17.00. Chemical Publishing Co., Inc. New York, 1956.

This up to date book is written mostly for cosmetologists, whether manufacturers, chemists, cosmeticians or allied professions. As such it is quite complete. It contains over 100 photographs, pictures and charts which greatly help the reader in his perusal of the text.

Yet it does more than that, otherwise plastics engineers would wonder why such a book is reviewed here. In its seven parts, the skin, care of the face, mouth, eyes, hair, body, hands and general aspects of cosmetic formulation, it gives data which are invaluable to the multitude of plastics technicians studying the fabrication of containers for the cosmetic industry.

They will find here what kind of reactions may possibly be caused on plastic materials by the various ingredients used, their pH, their synergistic or catalytic properties, the preservatives, germicides, fungicides used, odor transmission and retention, toxicity, allergy and many others.

This applies to face or hand creams, lotions, face powders, sun tan lotions, tooth pastes, mouth washes, shampoos, hair waves, dyes and tonics, soaps, detergents, deodorants, manicure preparations and hundreds of chemicals used in the complex manufacturing of cosmetics and packaged in plastics.

As such, it belongs on the desk of each of the many plastic specialists servicing the cosmetic industry.

Louis C. Barail

NOTE ALL SPE MEMBERS

that the

ANNUAL MEMBERSHIP LUNCHEON

will be held Wednesday, January 16, 1957

at the

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You will find this business luncheon geared to mesh with your forward thinking. You will be presented with a broad picture of the creative success already reached and the plans by which the future growth of the SPE is being plotted and will be achieved. These plans are built around YOU.

See you in St. Louis at the Membership Luncheon.

A Plastics Museum

Gentlemen:

The U. S. National Museum is engaged in enlarging its collections and exhibits for its new Hall of Tools. It is planned to have an historical series of exhibits showing the development of: Hand Tools, Mechanical Tools, Power Tools, Precision Tools, and Automatic Tools.

The Museum would like to obtain original models, or replicas of old tools that would be included in these categories, especially of those tools which mark a fundamental advance in the development of tools. Tools of which the date and maker can be adequately documented are especially desired. It would also like to obtain drawings, photos, plans, catalogs, etc., of old tools, as well as collections of professional papers, photos, etc., of men and firms who played important parts in the development of the tool industry. The Museum would also be interested in obtaining similar material for first development models of new tools which promise to be of historical significance.

The aims of the Museum in these collections are to make possible adequate and correct recording of the history of the tool industry, and in its exhibits to demonstrate to the public the central place held by tools and the men who invented and made them in the development of our industrial society.

Colonel Leslie S. Fletcher, Research Director for the American Society of Tool Engineers, has suggested that you could be of assistance to us in connection with the historical development of plastic tooling. Present plans for our Hall of Tools call for an exhibit of dies and die pressing. We should like to show some of the recent advances in this field—in particular application of plastic tooling in the aircraft and automotive industries. Can you assist us in obtaining representative examples of early plastic tooling, together with samples of the product? We would especially like to get those used in first development, together with explanatory diagrams and as much of their history as is available in order to have the story as complete as possible.

I understand that most of these plastic tools are rather large in size, but for exhibition purposes examples under 18 inches in any dimension would be preferred. Of course, when such items are exhibited full credit would be given to the donor and to the firm which developed them.

Robert S. Woodbury
Curator
Division of Engineering

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Epoxy-Butadiene Resins . . .

(Continued from Page 24)

As shown in Table IV, comparison of the dielectric properties of this same phthalic-anhydride-cured epoxy-polybutadiene resin with the requirements of Military Specification MIL-I-16923B, Insulating Compound, Electrical, Bedding, shows that the experimental resin meets the specified values for dielectric constant at all temperatures and frequencies, and the 1000-cps-dissipation-factor requirements at elevated temperatures. The dissipation-factor values do somewhat exceed the specified maximum allowable values at room temperature and at frequencies below 10 megacycles. A purified resin might meet all specifications for dielectric properties.

Acknowledgment

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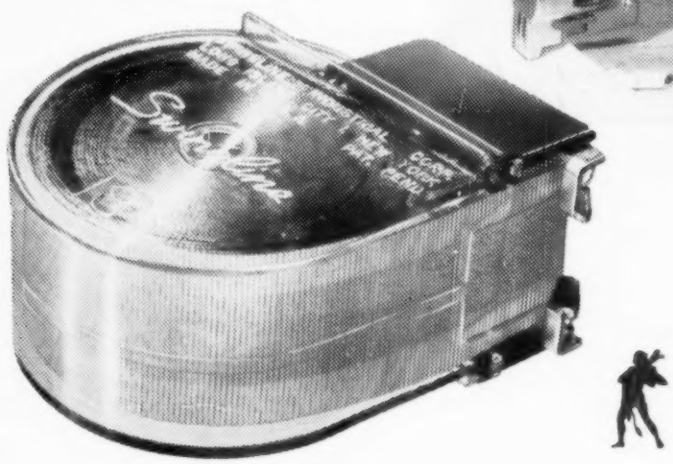

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